149 U.S. 48

RECORD, CASE No. 13,784.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1892.

TERM No., 192.

THE NATIONAL METER COMPANY, APPELLANT,

vs.

THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK.

FILED OCTOBER 16, 1889.

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1 The President of the United States of America to the Board of Water Commissioners of the City of Yonkers, Greeting:

[L. S.]

You are hereby commanded that you personally appear before the judges of the circuit court of the United States of America for the southern district of New York, in the second circuit court, in equity, on the first Monday of May, A. D. 1888, wherever the said court shall then be, to answer a bill of complaint exhibited against you in the said court by the National Meter Company, and do further and receive what the said court shall have considered in that behalf. And this you are not to omit under the penalty on you of two hundred and fifty dollars.

Witness Honorable Samuel F. Miller, associate *chief* justice of the Supreme Court of the United States, at the city of New York, on the 2d day of April, in the year one thousand eight hundred and eighty-eight, and of the Independence of the United States of America the one hundred and twelfth.

TIMOTHY GRIFFITH, *Clerk.*

BROADNAX & BULL,
Complainant's Sol'rs.

The defendant is required to enter appearance in the above cause in the clerk's office of this court on or before the first Monday of May, 1888, or the bill will be taken *pro confesso* against it.

T. G., *Clerk.*

2 NEW YORK, *April* 7, 1888.

We hereby accept service of the within process on behalf of the defendant.

T. L. LIVERMORE,
FREDERICK P. FISH,
Solicitor- and of Counsel for the Board of Water Commissioners of the City of Yonkers.

U. S. Circuit Court.
Filed Jan. 20, 1888.

JOHN A. SHIELDS, *Clerk.*

3 U. S. Circuit Court, Southern District of New York.

THE NATIONAL METER COMPANY, Complainant,
against
THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, Defendant.
} In Equity; on Bill, etc.

To the honorable the judges of the United States circuit court in and for the southern district of New York:

The National Meter Company, a corporation duly created, organized, and existing under and by virtue of the laws of the State of New York and having its principal place of business in the city, county, and State of New York, brings this its bill of complaint

against the Board of Water Commissioners of the City of Yonkers, a corporation created, organized, and existing under and by virtue of the laws of the State of New York and having its principal place of business in the city of Yonkers, in said State, and an inhabitant of the southern district of New York.

4 And thereupon your orator, upon information and belief, complains and says that before the fourth day of September, 1878, Lewis H. Nash, of the city of Brooklyn, in the county of Kings and State of New York, was the first, sole, and original inventor of a new and useful improvement in rotary water meters, not known or used before and not patented or described in any printed publication in this or any foreign country before his invention thereof and not in public use or on sale more than two years prior to his application for letters patent of the United States therefor, and did, on the said fourth day of September, 1878, apply to the Commissioner of Patents of the United States for letters patent for said invention, and did fully and in all respects comply with all the requirements of the law in that behalf.

That by a certain instrument of writing, duly executed and delivered by said Lewis H. Nash, bearing date on or about August 25, 1878, and recorded in the Patent Office September 4, 1878, at Liber J 23, page 136, of Transfers of Patents, the whole of said improvements were assigned to your orator, and by said last-mentioned instrument of writing the Commissioner of Patents was authorized and requested by said Nash to issue any patent that might be granted for said improvements to your orator, as assignee of the said Nash, as by said instrument of writing or a duly authenticated copy thereof, ready in court to be produced, will fully appear.

And thereupon, due proceedings being had according to law, letters patent of the United States were granted to your orator, its successors and assigns, for said improvements, as the assignee of said Nash, which letters patent were and are executed, recorded, issued, and delivered in due form of law and are dated January 21, 1879, and numbered 211,582, as by a duly authenticated copy of said letters patent, ready in court to be produced, as your honors may direct, will fully appear.

5 That by said letters patent there was granted to your orator, its successors and assigns, for the term of seventeen years from the date thereof, the sole and exclusive right to make, use, and vend the improvements in rotary water meters described and illustrated and claimed in said letters patent throughout the United States and the territories thereof, as by said letters patent will fully appear.

That a description and claim of said improvements in rotary water meters are given in a specification annexed to said letters patents and making part thereof, as required by law and as fully appears by said letters patent.

That said letters patent were, upon due investigation had, discovered to be inoperative and invalid by reason of a defective and insufficient specification and by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new, and which errors arose, as your orator is informed and

believes, by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention; and thereupon, for good and lawful cause as aforesaid, as by the statutes of the United States made and provided, the said Lewis H. Nash, with the consent and at the request of your orator, on the 18th day of December, 1886, surrendered said letters patent to the Commissioner of Patents and applied for new letters patent in due form of law for said invention in rotary water meters upon an amended specification, and did fully and in all respects comply with all the requirements of the law in that behalf.

And thereupon, due examination being had according to law by the Commissioner of Patents, it was adjudged that said Nash was justly entitled to new and amended letters patent for said invention; and thereupon, due proceedings being had according to law, there was granted to your orator, its successors and assigns, as sole assignee of said Nash and as the owner of the whole of said letters
6 patent and invention, a reissue of said letters patent upon an amended specification; that said reissued letters patent are in due form of law and are for the same invention described and illustrated in said original patent, are signed by the Secretary of the Interior and countersigned by the Commissioner of Patents and sealed with the seal of the Patent Office, and were duly delivered to your orator; that said reissued letters patent were applied for with reasonable diligence and as soon as said letters patent 211,582 were discovered to be inoperative and invalid as aforesaid; that said reissued letters patent are dated February 8, 1887, and are numbered 10806 of reissued patents and were duly recorded in the Patent Office according to law.

That by said reissued letters patent there was granted unto your orator, its successors and assigns, for the term of seventeen years from the twenty-first day of January, 1879, the exclusive right to make, use, and vend said invention throughout the United States and the territories thereof, as by said reissued letters patent or a duly authenticated copy thereof, ready in court to be produced, will fully appear.

That your orator is now the sole and exclusive owner of said letters patent and invention and of all rights of action thereunder accruing, and brings the same here in court ready to be produced as your honors may direct.

That said invention is of great public utility, and that your orator has expended large sums of money in the purchase of said letters patent and invention and in perfecting said improvements and in introducing the said invention in public use, and that your orator is now and has been manufacturing and selling said improvements in rotary water meters upon a large scale, and has been and is now ready to fully supply the public demand for the same, and but for the combination, infringements, misrepresentations, and wrongs hereinafter complained of would now be in the peaceful possession
7 and enjoyment of said reissued letters patent and invention and of the income derivable therefrom.

But your orator shows to the court that the defendant hereinbe-

fore named, as your orator is informed and believes, having notice of said original and reissued letters patent and well knowing all the facts and circumstances hereinbefore set forth, with the intent and effect of injuring your orator and in open and palpable disregard of its rights, has been and is now combining, confederating, and conspiring to injure your orator, to infringe said letters patent, and to use said invention and avail itself of the gains and profits derivable therefrom, to the great loss and damage of your orator; that said defendant has conspired with others, whose names are at present unknown to your orator, for the use of said invention and for a division between themselves of the gains and profits derivable therefrom.

That said defendant, without the license of your orator, against its will, in violation of its rights and of said reissued letters patent, numbered and dated as aforesaid, for said improvement in rotary water meters, has, in the southern district of New York, sold and used and caused to be sold and used by conspiring and combining with others as aforesaid, is now selling and using and causing to be sold and used as aforesaid, and intends still to continue to sell and use and cause to be sold and used, in the southern district of New York as aforesaid, said patented invention of an improvement in rotary water meters described and claimed in and by said reissued letters patent in some material parts thereof, the title to which is by law vested in your orator; and that said defendant, by such selling and using and causing to be sold and used, has and is now and intends to continue to infringe said letters patent in said southern district of New York, in some material part or parts thereof, by selling and using and causing to be sold and used rotary
8 water meters substantially the same in principle, purpose, construction, and mode of operation as the improvement in rotary water meters described, illustrated, and claimed in said reissued letters patent numbered and dated as aforesaid.

And your orator further shows unto your honors that it has repeatedly requested said defendant to desist from the infringement of your orator's rights under said letters patent as aforesaid, and that said defendant, notwithstanding said request and with the full knowledge of your orator's rights in the premises as above set forth, has continued wilfully and unjustly to infringe said letters patent, to the great gain and advantage of said defendant and to the great loss and damage of your orator.

That said actions and doings of defendant are contrary to equity and good conscience and are a manifest wrong and injury to your orator.

In consideration whereof, and forasmuch as your orator can have adequate relief only in this court, where matters of this sort are properly cognizable and relievable, and to the end that said defendant may, if it can, show why your orator should not have the relief hereby sought, your orator prays that the said Board of Water Commissioners of the City of Yonkers, over its corporate name and seal, and by such of its officers as have the management of its affairs, and to the best of his or their knowledge, remembrance, information,

and belief, full, true, direct, and perfect answer make to all the averments, statements of facts, and matters and things hereinbefore set forth and charged, and that as fully and particularly as if the same were here again repeated and the defendant especially interrogated thereto.

And your orator further prays that said defendant, its officers, agents, servants, attorneys, workmen, and employees, may be strictly enjoined and restrained, both preliminarily and finally, by a writ or writs of injunction issuing out of and under the seal of this honorable court, from directly or indirectly using or vending or causing to be used or vended said improvements in rotary water meters, any or either of them, or any substantial or material part thereof, described and claimed in said reissued letters patent, and such as it is now and has been using and vending, as hereinbefore set forth, or such as are substantially the same or as embody the said patented invention of your orator, and from in any way directly or indirectly infringing said reissued letters patent or any part thereof.

And your orator further prays that said defendants, its officers, agents, associates, and confederates, may be decreed to account for and pay over to your orator the gains and profits by them, or either of them, made or realized by using and vending said improvements in rotary water meters or any part thereof;

And that your honors may also assess or cause to be assessed the damages sustained by your orator by reason of such infringement, and that your honors may increase the actual damage so assessed to a sum equal to three times the amount of such assessment under the circumstances of the wilfull and unjust infringement by said defendant as herein set forth.

And may it please your honors to grant unto your orator not only writs of injunction, issuing out of and under the seal of this honorable court, directed to said defendants, its agents, servants, attorneys, workmen, and employees, each and every of them, commanding, enjoining, and restraining them and each and every of them, both preliminarily and permanently, as your orator has above and in that behalf hereby again prays, but also a writ of subpœna, issuing out of and under the seal of this honorable court, directed to the said The Board of Water Commissioners of the City of Yonkers, the defendant herein, commanding it to appear at a certain time and place in this court to answer the premises, and to stand to and abide by such orders and decrees herein as may be consistent with equity and justice and as may be made against it.

And your orator, as in duty bound, will ever pray, etc.

NATIONAL METER CO.,
By JOHN C. KELLEY, *Pres.*

[SEAL.]

AMOS BROADNAX,
J. EDGAR BULL,
Of Counsel.

BROADNAX & BULL, *Solicitors.*

STATE OF NEW YORK, }
County of New York, } *ss:*

John C. Kelley, being duly sworn, says that he is president of The National Meter Company, the complainant herein; that he has read the foregoing bill of complaint and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein stated to be alleged on information and belief, and as to those matters he believes it to be true, and that now, at the time of filing this bill, he verily believes that the said Lewis H. Nash was the first, original, and sole inventor of the invention described and claimed in said reissued letters patent upon which this suit is brought.

JOHN C. KELLEY.

Subscribed and sworn to before me this 31st day of March, 1888.

JNO. M. TULLEY,
Notary Public, N. Y. Co., N. Y.

(Endorsed:) U. S. circuit court, southern district of N. Y. National Meter Co. *v.* Board of Water Commissioners of the City of Yonkers. Bill of complaint. Broadnax & Bull, 120 Broadway, N. Y., compl't's sol'r-. U. S. circuit court. Filed April 2, 1888. Timothy Griffith, clerk.

11 T. L. Livermore. Frederick P. Fish.

Livermore & Fish, counsellors-at-law, 40 Water St., rooms 53–55.

Dictated. BOSTON, *April 14th*, 1888.

Clerk of the U. S. circuit court, southern district of New York, New York city.

DEAR SIR: Will you please enter our appearance for the defendants in the case of The National Water Meter Company *v.* Board of Water Commissioners of Yonkers, lately brought in equity in your court? Please also file the enclosed answer in that case and acknowledge that you have done so on enclosed postal card.

Yours truly, LIVERMORE & FISH.

(Endorsed:) U. S. circuit court, south. dist. N. Y. National Water Meter Co. *vs.* Board of Water Commissioners of the City of Yonkers. Appearance. Livermore & Fish, def't's sol'rs, 40 Water St., Boston, Mass. U. S. circuit court. Filed Apr. 16, 1888. Timothy Griffith, clerk.

12 Circuit Court of the United States, Southern District of New York. In Equity.

NATIONAL WATER METER COMPANY, Complainant,
vs.
THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, Defendant.

The answer of the Board of Water Commissioners of the City of Yonkers to the bill of complaint in the above-entitled cause.

This defendant, reserving to itself all right of exception to any and all matters contained in the said bill of complaint, makes answer thereto or to so much thereof as it is advised is material to be answered as follows:

13 I. This defendant is informed and believes that letters patent of the United States No. 211,582 were issued to the complainant as alleged assignee of Lewis H. Nash from the Patent Office of the United States, as alleged in said bill; but this defendant on information and belief denies that the said Nash was the original and first inventor of any new and useful improvement in water meters, as alleged in the bill of complaint, or of any invention or improvement described and set forth in said letters patent; denies that said letters patent were duly and lawfully issued; denies that said alleged inventions had not been known or used before, and that they had not been in public use or on sale in this country more than two years prior to said Nash's application for said letters patent, and that they had not been patented or described in printed publications in this or foreign countries before the said alleged invention of said Nash. This defendant further denies on information and belief that by said letters patent there were granted to the complainant any exclusive rights or any rights whatever to make, use, and vend the alleged improvements described and claimed in said letters patent.

II. This defendant is informed and believes that the said letters patent No. 211,582 were afterwards surrendered, and that new letters patent, bearing date the eighth day of February, 1887, and numbered 10806 of reissued patents and purporting to contain an amended specification, were issued from the Patent Office of the United States to the complainant; but this defendant on information and belief denies that by virtue of said reissue the said complainant became possessed of or entitled to an exclusive right or any right whatever in respect to the things therein described and claimed, and denies

14 that said reissued letters patent No. 10806 were obtained pursuant to any act of Congress or in accordance with any statutory provision whatsoever.

III. This defendant on information and belief denies that said original letters patent No. 211,582 were inoperative or invalid by reason of a defective and insufficient specification, or by reason of said Nash's claiming as his own invention or discovery more than he had a right to claim as new, in such particulars, or for such

causes that the said letters patent were or could be lawfully amended or said alleged defects cured by the said surrender and reissue, and denies that said alleged inoperativeness or invalidity was of such a character as might be cured by surrender and reissue; denies that any alleged errors in said original letters patent arose through inadvertance, accident or mistake, and without any fraudulent or deceptive intention on the part of said Nash and said complainant; denies that said reissued letters patent were lawfully issued, and denies that the application for said reissue was made with reasonable diligence and as soon as said original letters patent were discovered to be inoperative and invalid, as alleged in the complainant's bill.

IV. This defendant on information and belief denies that said complainant is now the sole and exclusive owner of said letters patent and invention or of any rights thereunder accruing; denies that the said alleged invention is of great or any public utility, and that the complainant has expended large sums of money in the purchase of said invention or in perfecting the same and introducing the same into public use, and denies that any acts of the defendant have interfered with the possession and enjoyment by said complainant of said reissued letters patent and invention and of the income derived therefrom, in so far as the complainant has or ever had any rights to the same.

15 V. This defendant, further answering, denies that it has ever injured the complainant or disregarded any rights of the complainant; denies that it has been or is now combining, confederating, or conspiring to injure the complainant or to infringe said reissued letters patent No. 10806, or to use said alleged invention therein shown and described, or to avail itself of any gains or profits derivable therefrom, and denies that it has conspired with any persons for the use of said alleged invention or for a division between themselves of the gains and profits derivable therefrom.

VI. This defendant, further answering, denies that it has, in the southern district of New York or elsewhere, made, sold, or used or caused to be made, sold, or used by conspiring and combining with others, or otherwise, or that it is now making, selling, or using or causing to be made, sold, or used, or that it intends to continue to make, sell, or use, or cause to be made, sold, and used as aforesaid said alleged patented invention shown and described in said reissued letters patent No. 10806 or any material or substantial parts thereof; denies that said defendant has infringed or is now infringing or intending to infringe said letters patent, in said southern district of New York or elsewhere, by making, using, or selling or causing to be made, used, or sold rotary water meters substantially the same in principle, purpose, and mode of operation as those shown and described in said reissued letters patent No. 10806 or illustrated in the claims thereof, or any material or substantial part thereof.

VII. This defendant, further answering, avers that it has in use in the city of Yonkers, in New York, may varieties of water meters, among others certain water meters manufactured by the Hersey Meter Company, which last-named meters this defendant is in-

formed and believes are the ones alleged by the complainant
16 to be an infringement of said letters patent; that said Hersey Meter Company is the owner of a large number of patents and inventions relating to water meters, among which are reissued letters patent of the United States No. 10776, granted to it as the assignee of James A. Tilden, which reissued letter, patent and the original thereof, No. 324,503, show and describe a water meter substantially different in construction and mode of operation from the water meter described and claimed in said Nash reissue No. 10806, and that it, said Hersey Meter Company, is engaged in manufacturing, selling, and introducing into use water meters constructed in substantial accordance with said Tilden reissue, among which are said Hersey water meters used by this defendant; that the Hersey meters so manufactured, sold, and introduced into use by the Hersey Meter Company and used by this defendant are substantially different from the water meters shown, described, and claimed in said reissued letters patent to Nash, No. 10806, and do not contain or embody any material or substantial part of the inventions shown, described and claimed, in said reissued letters patent No. 10806, and in particular do not contain or embody any of the combinations of mechanism purporting to be specifically pointed out and claimed in the several claims of said Nash reissue No. 10806.

VIII. This defendant further avers on information and belief that said Hersey Meter Company has for more than two years next prior to the filing of the bill in this cause been engaged in the manufacture and sale of water meters constructed in substantial accordance with said Tilden reissue No. 10776, and has in the manufacture and sale of such water meters come into competition with the complainant; that the complainant well knowing that the water meters so made, sold and introduced into use by said Hersey Meter Company did not infringe said original letters patent No. 211,582 or embody
any of the combinations of devices pointed out and claimed
17 in the claims thereof, surrendered said last-named letters patent and procured a reissue thereof, namely, said reissued letters patent No. 10806, for the sole purpose of claiming combinations of devices which were not the subject of any of the claims of said original letters patent or described as being the inventions of the said Nash, for which he applied for and obtained said original letters patent, but which, although they were in fact substantially different from any combination, of devices embodied in the water meters so made, solds and introduced into use by said Hersey Meter Company, the complainant hoped might be in said reissue described in language so ambiguous as to afford plausible ground to the complainant for alleging that such combinations of devices so claimed in said reissued letters patent were found in the said Hersey meters; that in so far as said original letters patent to Nash may have been inoperative or invalid or claimed more than that of which the said Nash was the first inventor, all the particulars in which the same were so inoperative or invalid and all the prior devices, if any, which were claimed by the said Nash in his said original letters patent, and which he was not entitled to claim therein, were well

known to the complainant and to the said Nash long prior to the application for said reissued letters patent, and that the complainant and the said Nash unreasonably and fraudulently delayed undertaking to correct said alleged defects by reissue in order that their said letters patent might on the face thereof seem as broad and comprehensive as possible, and that in spite of their knowledge of all the facts in the premises said Nash and said complainant did not make application for said reissued letters patent until said Hersey Meter Company had made and sold large numbers of water meters and until they learned that the said Hersey Meter Company were aware
18 of certain prior devides in the art which afforded them a completedefence to said original letters patent; whereupon said complainant and said Nash procured said reissued patent No. 10806, not for the purposes contemplated by the statutes of the United States authorizing reissues, but for the sole purpose of procuring new letters patent for other and different inventions from those forming the subject-matter of the claims of said original letters patent, with the view of thereby covering, if possible, the water meters made, sold, and introduced into use by said Hersey Meter Company and such as are used by this defendant and which were not covered by said original letters patent.

IX. And this defendant, further answering, on information and belief avers that said reissued letters patent No. 10806 are not for the same inventions as said original letters patent No. 211,582, but are for other and different inventions which the said complainant, as assignee of said Nash, even if said Nash were the inventor thereof, which this defendant utterly denies, was not entitled to claim by a reissue of said letters patent; that said letters patent were procured by deceiving the Patent Office and by fraudulent and untrue representations to the Patent Office; that whatever rights the complainant may have had to surrender said original letters patent No. 211,582 and to reissue the same it forfeited by its delay and laches in not so doing until long after it had full knowledge of all the facts upon which said application for a reissue purported to be based and until long after the said Hersey Meter Company had made, sold, and introduced into use water meters identical with the said Hersey meters used by this defendant and now alleged by the complainant to be an infringement of said reissued letters patent, and that said reissued letters patent are therefore in whole and in part absolutely void.

19 X. This defendant, further answering, avers that said Nash did not in his said original or in said reissued letters patent "particularly point out and distinctly claim the part, improvement, or combination which he claimed as his invention or discovery" in accordance with section 4888 of the Revised Statutes of the United States, but that, on the contrary, he wilfully and fraudulently made his claims in said original and said reissued letters patent in ambiguous language, intending to mislead the public with the view of making it difficult to determine the real scope of his said claims and of reserving the right to contend for such interpretation thereof as the exigencies of any particular case might, in his judgment or that

of his assignee, require, and these defendants aver that for this reason said reissued letters patent are invalid and void.

XI. This defendant further avers that the said alleged invention and improvement, or material and substantial parts of the same, described and claimed as new in said reissued patent No. 10806, and attempted to be patented thereby, were before the assumed or supposed origination or discovery thereof by said Lewis H. Nash patented in and by the following specified letters patent of the United States and described in the specifications thereunto respectively annexed, printed and published at the United States Patent Office, Washington, D. C., to wit:

No. 175,659, to J. B. Button, dated April 4, 1876.

No. 73194, to W. Payton, dated Jan. 7, 1868.

No. 207,862, to B. Fitts, dated Sept. 10, 1878.

No. 149,023, to G. H. Bailey, dated March 31, 1874.

XII. This defendant further avers that the said alleged invention and improvement, or material and substantial parts of the same, described and claimed as new in said reissued patent No. 10806 and attempted to be patented thereby were before the assumed or
20 supposed origination or discovery thereof by said Lewis H. Nash patented in and by the said following specified letters patent of the Kingdom of Great Britain and described in the specifications thereunto respectively belonging, printed and published at the Great Seal Patent Office, London, England, to wit:

No. 9744 of 1843, to Elijah Galloway, dated May 25, 1843, enrolled Nov. 23, 1843.

No. 11485 of 1846, to Elijah Galloway, dated Dec. 14, 1884, enrolled June 14, 1847.

No. 865 of 1852, to Charles Harford, sealed Jan. 19, 1853, and dated Nov. 25, 1852.

XIII. This defendant further avers that the said alleged invention and improvement or material and substantial parts of the same described and claimed as new in said reissued letters patent No. 10806 and attempted to be patented thereby were, before the assumed or supposed origination or discovery thereof by said Lewis H. Nash, described in the printed publications hereinafter specified and respectively entitled and published as follows:

Kinematics of Machinery, by F. Reuleaux, translated and edited by Alex. B. W. Kennedy, C. E.; published by MacMillan & Co., London, England, 1876; pages 433, 434, and 435.

The Artisan, a monthly publication published in London, England, in the number for November, 1849, page 243.

XIV. This defendant, further answering, avers that the alleged invention and improvement or material and substantial parts of the same described and claimed as new in said reissued letters patent and attempted to be patented thereby did not, at the time of the assumed or supposed origination or discovery thereof by said Lewis H. Nash, constitute any new and useful art, machine, manufacture, or composition of matter or any useful improvement thereof within the meaning and intent of the statutes of the United States
21 relating to the grant of patents for inventions; that the things

and combinations respectively specified and recited in the several claims of said patent as embraced in the alleged invention and improvement thereby attempted to be patented do not exhibit or embody any substantial variation or change from what had belonged to the state of the art as it existed at the time of said Nash's assumed or supposed origination or discovery of the same and did not then involve the exercise of the inventive faculty nor constitute patentable invention nor the proper subject of valid letters patent, but had already become matter of common knowledge among those skilled in the art relating to rotary engines, pumps, motors, and meters, and that for this reason said patent No. 211,582 is invalid and void.

XV. And this defendant, for the reasons hereinbefore recited, submits that it ought not to be decreed to account to the complainant nor to pay anything in the nature of profits or damages, nor to be enjoined as in the said bill of complaint is prayed; but, without admitting that any other matter contained in said bill of complaint material to be answered unto and not herein already sufficiently answered is true to its knowledge or belief, submits that the complainant is not entitled to any relief whatsoever against this defendant; all of which this defendant is ready to aver, maintain, and prove as this honorable court shall direct, and prays to be hence dismissed with reasonable costs and charges in this behalf most wrongfully sustained.

THE BOARD OF WATER COMMISSIONERS
OF THE CITY OF YONKERS,
By LIVERMORE & FISH, *Its Solicitors.*

T. L. LIVERMORE,
FREDERICK P. FISH,
Of Counsel for Defendant.

(Endorsed:) Circuit court of the U. S., southern district of New York. In equity. National Water Meter Co. *v.* Board of Water Commissioners of the City of Yonkers. Defendant's answer. U. S. circuit court. Filed Apr. 16, 1888. Timothy Griffith, clerk.

22 United States Circuit Court, Southern District of New York.

THE NATIONAL METER COMPANY, Complainant,
vs.
THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, Defendant. } In Equity.

Replication.

This replicant, The National Meter Company, saving and reserving unto itself all and all manner of advantage of exception to the manifold insufficiences of the answer of the defendant to the bill of complaint herein, for replication thereunto saith that it will aver and prove its said bill to be true, certain, and sufficient in the law to be answered unto, and that the said answer of the said defendant is uncertain, untrue, and insufficient to be replied unto by this

replicant; without this, that any other matter or thing whatever in the said answer contained material or effectual in the law to be replied unto, confessed and avoided, traversed or denied, is true; all which matters and things this replicant is and will be ready to aver and prove as this honorable court shall direct, and humbly prays as in and by its said bill it hath already prayed.

BROADNAX & BULL, *Solicitors.*

(Endorsed:) United States circuit court, southern district of New York. In equity. National Water Meter Company, complainant, *vs.* The Board of Water Commissioners of the City of Yonkers, defendant. Replication. Broadnax & Bull, complainant's sol'rs, 120 B'way, N. Y. U. S. circuit court. Filed Apr. 24, 1888. Timothy Griffith, clerk.

23 Southern District of New York.

THE NATIONAL METER COMPANY, Complainant,
vs.
THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, Defendant. } In Equity.

NEW YORK, *June* 2, 1888.

Parties meet pursuant to agreement.

Present: Messrs. Broadnax & Bull, for complainant; Messrs. Livermore & Fish, for defendant.

Testimony taken on behalf of complainant under and pursuant to equity rule 67, as amended, before Samuel M. Hitchcock, a standing examiner of this court, at No. 120 Broadway, New York city.

Complainant's counsel offers in evidence a printed Patent Office copy of reissued letters patent No. 10806, in suit, granted to complainant as assignee of Lewis Hallock Nash, issued February 8, 1887, being a reissue of letters patent No. 211,582, of January 21, 1879, to the same party, and the same is marked Complainant's Exhibit A, June 2, 1888.

Complainant's counsel also offers in evidence a printed Patent Office copy of letters patent No. 211,582, granted to complainant Jan'y 21, 1879, as assignee of Lewis Hallock Nash, being the
24 original patent on which the reissue in suit was granted, and the same is marked Complainant's Exhibit B, June 2, 1888.

Defendant's counsel consents that the printed Patent Office copies, marked Exhibits A and B, in evidence shall have the same force and effect as if the same were duly certified.

Complainant's counsel also offers in evidence an assignment from Lewis Hallock Nash to the complainant of the invention covered by the patent in suit and the letters patent issued therefor, said assignment being dated August 21, 1878, and recorded at the Patent Office in Liber J 23, page 136, of Transfers of Patents, September 4th, 1878, and the same is marked Complainant's Exhibit C, June 2, 1888.

Complainant's counsel also offers in evidence a water meter known to the trade as the "Hersey meter," and the same is marked Complainant's Exhibit D, June 2, 1888.

Defendant's counsel admits that the meter marked in evidence Exhibit D is in all respects similar to or identical with meters which the defendant has, prior to the commencement of this suit, used in the southern district of New York, and that the defendant is still using such meters.

Defendant's counsel admits the incorporation of the corporation complainant and its residence, as alleged in the bill of complaint herein.

Defendant's counsel admits, for the purposes of this suit, that the defendant is a corporation duly organized and existing under
25 and by virtue of the laws of the State of New York, under the name of the Board of Water Commissioners of the City of Yonkers, and by that name it may sue and be sued in this court. They also admit that said defendant has its principal place of business in the southern district of New York.

Defendant's counsel also admits that the meter above offered in evidence and marked Complainant's Exhibit D was manufactured by the Hersey Meter Co., a corporation having its principal place of business in Boston, Massachusetts, of which Charles H. Hersey is president and Francis C. Hersey is treasurer, and that the said meter was supplied to defendant by the said Hersey Meter Company. They also admit that said meter is manufactured under letters patent granted to one James A. Tilden. They also admit that the conduct of the defense in this cause is under the direct control of said Hersey Meter Company and is being conducted by counsel of their own choice and in their employ, and that the expenses hereof are being and will be borne solely by them.

26 *Henry L. Brevoort's Direct.*

HENRY L. BREVOORT, a witness produced on behalf of the complainant, being duly sworn, deposes as follows:

1 Q. What is your name, age, residence, and profession?

A. Henry L. Brevoort; I am thirty-nine years of age; I reside in Brooklyn, N. Y., and am by profession a mechanical engineer.

2 Q. What experience have you had in the practice of your profession, and have you ever been called upon to testify as an expert witness in suits relating to patents?

A. From the age of eighteen, when I went into a machine shop, I have been constantly engaged in mechanical operations of various kinds, such as designing and testing machinery and the like. For the last fifteen years I have been principally engaged in examining patents and patented devices, and during this period I have been very frequently called upon to testify as an expert witness in suits relating to patents and patented devices. I have been so called in about five hundred cases.

3 Q. Have you had any experience in the construction of steam machinery, such as rotary engines, pumps, and the like?

A. I have had considerable experience in the construction and manufacture of both rotary and directing engines. I have for a number of years interested myself in the construction of rotary engines, and had at one time a collection of drawings representing a great number of such engines.

4 Q. I place in your hand reissue letters patent No. 10806, granted to National Meter Co., assignee of Lewis Hallock Nash, Feb. 8, 1887, marked Complainant's Exhibit A. Have you read this patent and do you understand the various forms of mechanism therein described?

27 A. I have frequently read the patent, and I think that I understand the various forms of mechanism set forth and described in the said patent.

5 Q. Are you acquainted with the art relating to engines having rotary pistons and analogous structures?

A. I am. Among other patents and publications describing such devices I have seen and read the English patent of Elijah Galloway, No. 11485, dated in the year 1846. I have also read a portion of Rouleaux's Kinematics of Machinery. I refer to pages 433 to 435 in an edition published at London by Macmillan & Co. in the year 1876 and translated by Alex. B. W. Kennedy. In the Galloway patent an engine is described having a piston with projections upon it, moving within a case provided with projections, the piston having an eccentric movement within the cylinder. In the book Kinematics of Machinery devices are described which, it is stated, may be used as motors, in which the pistons are provided with projections, and which pistons also operate within cases provided with projections, the said pistons having eccentric movements within their cases and rotating on their axes during their operation. None of these devices are described as water meters, but they all show devices capable of measuring liquids, which is true of all engines. It is true that engines are not adapted without certain changes to act as meters, and to adapt old engines and turn them into practical water meters for commercial use furnishes a broad field for invention.

6 Q. What do you understand to have been the improvement in the art of measuring water introduced by the invention of Nash?

A. As I understand what Nash did, it was as follows: He made a meter having a free or untrammelled piston, which could float in the current and move around within a case eccentrically, said piston being made of a material approximating the specific gravity of water, the piston in its movement opening and closing the inlet and outlet ports and therefore acting as its own valve.

28 7 Q. Please refer to comp't's reissue 10806, Exhibit A, and state what you understand to be the inventions set forth in the 3rd, 4th, 5th, and 6th claims thereof, and please compare the said inventions with the structure which I now show you, marked "Comp't's Exhibit D," which is defendant's meter.

A. The reissue referred to describes a water meter intended for measuring the amount of water passing through a pipe leading into and out from the case of a meter. Within the case is a floating pis-

ton, in the preferred form practically uncontrolled by any crank or guide. The general theory upon which the device works is as follows: The piston during its movement within the case and with the current forms chambers of changing volume in connection with the case, which chambers as they enlarge receive the water and at the appropriate time after the chambers have reached their full capacity, discharge the water. As the piston moves around the case, these chambers are formed and their volume is altered successively, so that more than one chamber is always in action, receiving and discharging water. In the form shown in the patent the case of the meter is provided with recesses, and the piston is likewise recessed, so that the recesses and projections of the piston co-operate with the recesses and projections of the case to form said measuring chambers in succession, which chambers change their volume as the piston moves eccentrically within and around the case. In the form shown in the patent the piston and the case are so proportioned in relation to each other that as the piston moves in its eccentric path it also rotates on its own center. The piston is so shaped in relation to the openings in the case as to open and close the induction and eduction ports as the piston moves around in the case. In this way the separate controlling valve, as shown in Fig. 7, is avoided and the mechanism is simplified, while its mode of operation is more accurate than when a separate valve to control the opening and closing of the ports is employed.

It is impossible in words to give an exact description of the movement of the parts of the meter, and this will have to be seen to be clearly and distinctly understood; so I will not attempt further to describe the movement of the parts, and will turn to the claims to which my attention is called. I notice that in each claim the following language appears:

"A piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to affect its diversion at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet."

Now, I understand that this language describes a piston and case having the movements which are found in the Nash meter—that is to say, it describes a piston having alternate bearing points or projections and, necessarily, recesses between the projections. It describes a cylinder chamber also provided with bearing points or projections and, necessarily, recesses, within which cylinder chamber is the piston. The piston within the cylinder chamber has an eccentric or side-rocking movement across the center of the said chamber upon continually changing lines, which movement of the piston effects the division of the chamber at two or more points on its sides into receiving and discharging spaces, which communicate with the inlet and outlet.

30 Now, this is precisely the operation of the Nash meter when measuring water. The different forms shown in the drawing cause the movements in each case to differ in some regard, but the description is accurate of all the forms shown. Now, I do not understand that a meter having alone these features is the subject-matter of any of the claims of this reissue, for I find in the reissue a disclaimer in the words I have quoted from the claim; and this disclaimer says that in the English patent of Galloway, No. 11485 of the year 1846, is shown and described an engine having the features specified in the quoted words from the claim; but this engine of Galloway's, as it exists in the Galloway patent, is intended to supply motive power and is not adapted, in the form it there appears, to act as a commercial or successful meter for measuring water, or, in fact, a meter having any practical value whatever; and the inventions specified in the claims of the reissue relate to those features described by Nash, which are adapted to make a successful and practical commercial water meter out of such an engine as Galloway describes, and which engine is substantially the same mechanism as the Nash water meter, minus the improvements specified in the claims, and to which I will refer later on.

Now, I think it is clear that the Galloway engine, as shown in the patent, is clearly the same thing as the Nash meter, minus those improvements that Nash added to make the device a commercial water meter. It is true that the Galloway patented engine has a piston which does not rotate upon its own center, while the Nash meter has a piston that does rotate upon its own center, but in both cases the pistons of the Galloway patent and of the Nash meters have alternating recesses and projections and in both are cylinders having interior projections and recesses, and the piston- in both cases have an eccentric movement within and upon continuously changing lines, the piston, while moving upon these continuously

31 changing lines, passing across the center of the cylinder chamber and dividing it at two or more points on its sides into receiving and discharging spaces, which communicate with the inlet and the outlet. There is nothing in the description in the Nash claims referred to which describes a piston that rotates upon its own center; and this rotation of the piston on its center is merely a feature due to the construction adopted by Nash, in which the piston has one less projection than the case, but the same structure is arrived at whether the piston has the same number of projections as the case or a different number. In both cases the water is measured in the same way—that is, chambers are formed between the pistons and cases, which chambers enlarge as the water enters them until they have reached their maximum capacity or sizes, when the water is measured, and as the chambers decrease in size the water flows from them to the outlets, and in both cases these chambers are formed in succession by the eccentric movement of the piston.

I will now turn to the special features of the claims which distinguish the Nash invention from a structure such as the Galloway patented structure.

Turning to the (3) third claim I find that a piston is described

which is provided with internal water passages. This is a feature of great advantage, particularly in a meter, as it admits of the passage of the water through the piston, which feature both increases the capacity of the mechanism and tends to simplify the valve arrangement when the piston itself forms the valve, opening and closing the ports by its own movement.

Turning now to the (4) fourth claim I find there described the general features above referred to combined with a piston having a free movement within the cylinder, controlled only by the shape of the piston, the shape of the cylinder, and the flow of water through the meter. This is a feature of very great advantage, espe-
32 cially in a water meter, for it greatly decreases the friction and greatly enhances the operation of the parts, allowing them to fit accurately without an attempt to force the parts into contact, as would be the case when an eccentric or crank is used. When the piston is free it can move around the case, adapting itself to the case whether it be absolutely true or not, with the minimum of friction, and ensuring the most perfect fit that the parts are capable of giving. With a free piston the minimum wear takes place, the meter remaining after the wear substantially as accurate as before.

The claim five is for the same combination as the 4th, but involving as a feature of the construction a piston formed of hard rubber.

It is highly important that the piston should be of a material strong, capable of standing wear, and which is not effected by water, and which will not change its shape by reason of its prolonged immersion in water, and which will approximate in weight to an equal bulk of water. These conditions are fulfilled by hard rubber and other kindred substances which I understand to be its equivalents, such as celluloid, which, like rubber, approaches in weight to water. It must be born- in mind that the piston of this meter is, as it were, floating in the passing stream, and the nearer it approximates to the weight of water the better and more easily it will float, and this is of great advantage where it is desired to turn the piston with as little effort as possible, for in a meter everything that tends to check the piston is disadvantageous and is avoided as much as possible. Though the claims refer to pumps and motors, they also particularly refer to water meters, and the patent is specifically directed to the construction of meters and includes the best features for a meter as distinguished from a motor or pump, though the devices shown can be adapted for the purposes of motors and pumps.

33 The 6th claim contains, in addition to the description indicative of the mechanism upon which the improvements are made, the following: "combined with ports controlled by said piston itself in its motion in the said chamber." This is a very important feature in a water meter, where simplicity of construction and ease of operation are of such great importance. It will be seen on turning to the drawings of the patent how much simpler the construction of the meter shown in figure 3 is than the meter shown in figure 7. In the first example the invention of the claim is present and in the second it is not. The use of the piston as a valve

cheapens the construction of the meter and decreases the power necessary to operate it, which, as I have before said, is a vital point in a meter.

In a water meter it is desirable that the pressure or head of water should be but slightly lost in its passage through the meter, the less the loss, other things being equal, the better the meter; and when the piston forms the valve itself the power required to drive a separate and independent valve is not expended, and consequently there is not the same loss in pressure as there would be in a meter in which, besides the driving of the piston, the water had also to drive a separate and independent valve.

I will now turn to the Hersey meter, Complainant's Exhibit D, and compare the same with the claims to which I have referred. Before doing so, however, I will state that the Tilden meter is in substance the Galloway patented engine with the improvements of the Nash patent added thereto, which changes make the device commercial as a meter. I have before given my reasons why I thought that the Galloway patented engine was substantially the same mechanism minus the improvements of Nash that I find described in the reissue and in each of the claims thereof referred to and disclaimed in the disclaimer contained therein. The Galloway
34 patented engine being old, I am clearly of the opinion that the Tilden meter, in view of the state of the art, is an equivalent for the forms of mechanism that Nash has improved. I think it is clear that the Tilden meter contains a piston having projections and recesses placed within a cylinder chamber having also recesses and projections, the piston having an eccentric movement across the centre of said chamber upon continuously changing lines to effect its division at two or more points at its sides into receiving and discharging spaces which communicate with the inlet and outlet, which language appears in each of the claims and also in the disclaimer where the Galloway patented engine is disclaimed. This language, as appearing in each of the claims referred to, is equally applicable to the Tilden meter, the Nash meter, or the Galloway patented engine. Now, for these reasons I am of the opinion that the language describing the mechanism in each of such claims is accurately descriptive of the Tilden meter as well as of the Nash meter, and that by reason of the existence of the Galloway patented engine it can most assuredly be said that, so far as the descriptive language used by Nash in each of these claims is concerned, the Tilden meter is without any doubt substantially the same thing as is contained in the descriptive language of the Nash claims.

I might here refer to the book "Kinematics of Machinery," where motors are shown and delineated having pistons with recesses and projections working within cases having recesses and projections, the projections of the pistons being one less than the projections of the cases, and which, when in operation with the cases, rotate on their own axes, operating precisely in the way of the Nash mechanism, minus the improvements added by Nash and which makes his meter a practical and commercial meter.

Thus, before the date of the Nash patent two forms of
35 motors or meters were known—one form, to wit, the form shown in the Galloway patent, which is the form adopted by Tilden, and another form, to wit, that shown in the "Kinematics of Machinery," also invented by Galloway, in which the projections of the piston and the case were not alike in number, and giving a piston which in operation rotated on its own axis, and which is the form of mechanism adopted and improved by Nash to make a commercial meter. Now, disregarding what Nash did, the state of the art clearly shows that the form of meter or motor in which the piston revolved on its own center as it moved eccentrically in the case was a well-known equivalent form for that structure in which the piston moved eccentrically in the case but did not revolve on its own centre. From this state of the art I have no hesitation in saying that, outside of the improvements of Nash, the Tilden mechanism and the Nash mechanism are the same.

I will now turn to the claims and compare them with the Tilden meter.

The third claim is for a piston in a meter of the description referred to provided with internal water passages. A glance at the Tilden meter shows that the piston is provided with internal passageways, down through which a part of the exhaust takes place. I have not omitted to take into consideration the fact that in the Nash meter some of the passageways in the piston are used as "outlets" and some as "inlets," while in the case of the Tilden meter the passageways in the piston are only used for the exhaust or outlet, but, nevertheless, there is no doubt in my mind that the invention of the said third claim is found in the Tilden meter.

Going now to the fourth claim, the mechanism of the meter is described and the piston is referred to as having a free movement within the cylinder controlled only by the shape of the cylinder, the shape of the piston, and the flow of water through the meter.
36 It is perfectly obvious, on an inspection of the Tilden meter, that the piston thereof is free in identically the way described, giving the same beneficial results and achieving the same end and objects as are achieved and desired in the case of the Nash patent; consequently I think that the invention of the fourth claim is present in the Tilden meter.

The fifth claim is for the same combination of parts, but involving a piston made of hard rubber. The piston in the Tilden meter is made of hard rubber, and all the benefits that flow from the use of such a piston in the Nash meter is had by the Tilden meter, and consequently the Tilden meter contains the invention of the fifth claim.

The sixth claim, after describing the meter, states that it is combined with ports controlled by the said piston itself in its motion within said chamber. In the Tilden meter this combination is taken advantage of and the piston in its movements in the meter chamber controls the ports, opening and closing them by its own motion; therefore the invention of the sixth claim and the advantages that flow therefrom are present in the Tilden meter.

As a matter of fact, Nash took one form of the Galloway engine (which we may designate the Galloway kinematic engine) and added certain improvements to it, and thus made a meter of commercial value, while Tilden took the other well-known form of the Galloway engine (which we may designate the Galloway patented engine), and taking Nash's improvements added them thereto and made a metor precisely like Nash's, except that the form of Galloway engine selected was not the form selected by Nash, though the improvements added thereto were precisely the improvements which Nash added to the form of Galloway engine selected by him.

37 NEW YORK, *June* 5, 1888.

Met pursuant to agreement.

Present: Counsel as before, and the cross-examination of Mr. BREVOORT by Mr. FISH was commenced and continued as follows:

8 X Q. The third, fourth, fifth, and sixth claims of the Nash reissue, to which alone you have referred in your direct examination, speak of the piston of the Nash meter as having "an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet." What do you understand to be the movement therein referred to as "eccentric" or "side-rocking"?

A. In the drawings of the patent different forms of meters are shown. In some of the forms—for example, in figure 3—if a point on the piston be selected it will be found that the point forms small arcs in the movement of the piston. In other forms shown this is not the case. I think that the term "side rocking" was used as descriptive of those forms in which the arcs would be formed by such an imaginary point upon the piston, the piston having a motion that might be called side-rocking while describing these arcs. The eccentric motion described is had by the piston during its movements within the cylinder.

9 X Q. What forms shown in the drawings or described in the specification of the Nash reissue are so organized that a point will not form the small arcs referred to in your last answer?

A. Figures 10 and 11.

10 X Q. What will be the character of the lines traced by a point of the piston of figures 10 and 11?

38 A. I refer to an illustrative model showing the various forms of meter illustrated in the patent, so far as the case and piston movements of the several meters are concerned. It will be seen that figures 3, 12, and 9 of the patent show meters in which the central point of the piston in the movement of the same within the case forms small arcs in the piston's movement, while in the case of figures 10 and 11 the central points of the piston move in a circle.

Model referred to by witness in his last answer is offered in evidence and marked Complainant's Exhibit E, June 5, 1888.

11 X Q. What is the path of any point you may select on the piston away from the centre, first, in figures 3, 9, and 12 and, second, in figures 10 and 11 ?

A. A point away from the centre in each case will describe arcs, some forming loops, and some, I think, not; for example, in figures 3 and 12 I should think as the point is selected further from the centre the longer would be the arc formed by the imaginary point. At the centre simply arcs would be formed, I imagine, though I have not tried it, that as the point was carried away from the centre the arcs would cut into one another, forming loops. Whether this would be true, so far as the loops are concerned, by a point—we will say, a thousandth of an inch from the centre—is a refinement which I have not gone into. I should think the same statement would be true of figure 9, but in the case of figures 10 and 11 I should not think loops would be formed, though to definitely settle the question in my own mind I should have to make an experiment. I now offer, if the counsel for defendant will locate the points the motions of which he wishes to enquire about, to bore small holes in the pistons of Exhibit E, and in this way determine exactly by scratches on the bottom of the case what the motions of the several figures are.

39 Counsel for defendant indicates the points and, a pin point being inserted at the points indicated, the exhibits are marked by revolving the piston with the pin point against the base.

The tracings obtained as above described are as accurate as can be obtained with the illustrative model, Exhibit E, the pistons of which do not fit the cases as the pistons of a working meter would fit its case. The tracings show that what I stated was correct, and that figures 3, 9, and 12 form loops and figures 10 and 11 do not.

11 X Q. Do you find any justification in the specification for your conclusion that the designation " side-rocking " is limited in its application to those forms in which arcs would be formed by an imaginary point upon the piston.

A. I find all through the specification the terms eccentric or side-rocking as applied to all of the figures, and in some of these figures I find a motion which, to *to* my mind, is definable by the term side-rocking, while in some of the other figures the term does not seem to apply in the same way; but this precise statement does not occur in the specification.

12 X Q. Is it not true that in all the forms shown in the drawings of the Nash reissue the piston effects its movement by successive side-rockings on successive points of its periphery ?

A. I don't know that I understand the question exactly, but I will say, no.

13 X Q. Is it not true that in all the forms shown in the Nash reissue the piston rocks sidewise, bringing one point of its periphery after another into bearing with successive points on the inside of the case ?

A. Undoubtedly, as the piston operates the points of the periphery are one after another brought into bearing with successive joints on

the inside of the case. The reissue itself says that this in
40 the various figures is accomplished by an eccentric or side-rocking movement. Thus I fail to see that the term side-rocking is applicable in the same sense to figures 10 and 11 as it is to figures 3 and 12, for example.

14 X Q. In all of the figures shown in the reissue is it not true that in the movement of the piston or during a part of its movement one side of the piston is moving faster and through a greater space than the approximately opposite point?

A. Yes.

15 X Q. And may not that movement referred to in the last question be fairly called side-rocking?

A. I must stick to the terms of the patent. When all the figures are taken into consideration the movement of the piston may be termed eccentric or side-rocking. Thus in figures 3, 9, and 12 the movement might be said to be eccentric and side-rocking.

16 X Q. Do you find in the Nash reissue any definition of "side-rocking" or any description of the movement called "side-rocking" which is inconsistent with the proposition that the word refers to the movement set out in cross-interrogatory 14?

A I do. The patent, in describing the figures, carefully refers in each case to the eccentric or side-rocking motion of the piston, and this language, it seems to me, indicates that the intention was not in any sense to limit the Nash meter to one having a piston which performs strictly side-rocking motions. If the term side-rocking had been used to express alone the motion referred to in cross-question 14, then the term eccentric would not have in each case been added thereto. I see no object in defining the motions of the various pistons by two terms unless they were used to express the differences between the motions which the pistons of the various meters of the patent had.

17 X Q. In your answer to cross-interrogatory 8 you state
41 that, in your opinion, "side-rocking" is used as descriptive of those forms shown in the drawings of the Nash reissue, in which arcs would be formed by an imaginary point upon the piston. Are those structures side-rocking; and, if so, what is the peculiarity of their movement that makes that designation applicable?

A. The peculiarity is the formation of arcs by the axial point of the piston.

18 X Q. Would every piston whose axial point forms arcs be side-rocking?

A. I answer for the forms before me. What might be done I cannot answer for in structures whose movements are as complex as are these.

19 X Q. What is the path of the axial point of the structure in figure 11?

A. A circle.

20 X Q. Then it is your view that structure, figure 11, is not side-rocking because its axial point does not trace arcs such as are traced by the axial points of the pistons of figures 3, 9, and 12, although the axial point of the piston of figure 11 traces a circle. Is that correct?

A. It is, as I understand the question. Figures 3, 9, and 12 have a piston the axial point of which traces a succession of arcs the convex sides of which are towards the centre of the meter, while in figures 10 and 11 the central point of the piston traces a circle around the centre of the meter.

21 X Q. The 3d, 4th, 5th, and 6th claims of the Nash reissue, to which you have referred, speak of the eccentric or side-rocking movement of the piston as being "within and upon continually changing lines across the center of said chamber." Please explain what is meant by the movement "within and upon continually changing lines across the center of said chamber."

A. As I understand this language, it might be read this way, and to my mind the language is intended to mean, that the piston is to have an eccentric or side-rocking movement across the centre of the
42 chamber, within it and upon continually changing lines, to effect the division of the chamber into receiving and discharge spaces. The language seems to me to express clearly enough the movement of the piston. The piston moves within the chamber upon continually changing lines. It moves across the centre of said chamber, and effects its division at two or more points on its sides into receiving and discharge spaces.

22 X Q. What do you understand to be the meaning of the word "within" in the phrase "within and upon continually changing lines?"

A. I think the word "within" merely expresses that the piston moves within the confining limits of the case.

23 X Q. Do you find any structure suggested or described in the Nash reissue except the structures in which the piston has what is called in the patent a compound motion—that is to say, an eccentric or side-rocking movement and in addition thereto a motion of revolution about its own axis?"

A. That is all that is described.

24 X Q. Which of these movements, if either, do you find in the Hersey meter used by these defendants?

A. I find the eccentric movement.

25 X Q. Do you find the side-rocking movement in the sense in which you understand that phrase to be used in the Nash reissue or in any sense?

A. No.

26 X Q. How would you define the word "eccentric" as used in the specification and claims of the Nash reissue?

A. I would define it as describing a piston that moved about in its case eccentrically—that is, the centre of the piston moving eccentrically to a circle which represented what might be called a pitch-line of the case or a piston whose centre moves about the centre of the case, approaching the sides on its movement in the manner of an eccentric.

43 27 X Q. Have any of the Nash structures an eccentric movement within the definition you have just given; if so, which of them?

A. I think they all have.

28 X Q. Do you find any suggestion in the Nash reissue that that motion of revolution of the piston about its own axis is not an essential characteristic of the Nash structures, or that it may be dispensed with?

A. I find no description stating that it can be dispensed with, except that in the first six claims no reference is made to its rotation upon its own axis.

29 X Q. Would any of the structures of the Nash reissue be operative for the purpose intended if the piston did not have the movement of rotation upon its own axis in addition to the eccentric or side-rocking movement?

A. Not if constructed exactly as shown in the drawings, but a change of configuration and the addition of a projection to the piston would make some of the structures operative and would not involve the rotation of the piston upon its own axis. I may add, though the question does not call for it, that such changes were within known mechanical knowledge at the date of the Nash patent.

30 X Q. How many receiving and discharging spaces are there at any given position of the piston in the structures of the Nash reissue and what is their relation to the piston?

A. Taking figures 3 and 12, I should think there were two or three chambers receiving and two or three discharging. It may be that in the arrangement of the ports that at some time but two are receiving, two discharging, and two are neutral. Substantially the same thing would be true of figure 9. In figures 10 and 11 two spaces are receiving and one discharging or in another position two are discharging and one is receiving.

44 31 X Q. Are the several discharging, and receiving chambers, when two or more are either receiving or discharging, connected so that water passes from one to the other freely?

A. In figures 3 and 12 two or three chambers are connected while they receive, and two or three chambers are connected while they discharge. In the other figures the chambers are not connected during receiving and discharging.

32 X Q. Describe how the structures of the Nash reissue operate to measure the water passed through them.

A. The water is allowed to enter a chamber when at its minimum capacity of reception. The water enters the chamber until the chamber has increased to its maximum capacity of reception. After this it is discharged as metered, and the movement in the case of the piston turns an index which gives in cubic feet the amount of water passed through. Each chamber in all the structures is first a receiving chamber, then a neutral chamber, and then a discharging chamber, the chambers being formed between the projections of the piston and case.

33 X Q. In the Hersey meter is each chamber first a receiving chamber, then a neutral chamber, and then a discharge chamber? If not, how is it organized?

A. Each recess in the case of the Hersey meter is at times divided into two chambers by a projection from the piston. When the projection enters a recess a receiving chamber is formed between the

case and the projection from the piston, and a discharge chamber is formed on the other side of the projection, and when the recess is not divided no water is being received or discharged in that space. As the projection from the piston travels round in the recess of the case the receiving chamber is being enlarged and the discharging chamber is being contracted, and the projection from the piston leaves the case and meets it again to repeat these operations.

45 34 X Q. At the moment when any projection in the piston is withdrawn from any contact with one of the projections of the case, how many neutral cavities, or cavities in which there is no water being received or discharged, are there in the meter?

A. Three.

35 X Q. In the structures of the Nash reissue how many chambers are neutral at any given time?

A. In all of the structures one chamber is neutral at a time before the discharge, and another is neutral just before the inlet of the water. With a greater number of points on the piston and case, there would be more neutral chambers at the same time.

36 X Q. If I understand your direct deposition, you distinguish the subject matter of the 3d claim of the Nash reissue from what was old in the art by the fact that the piston therein referred to is described as having internal water passages. Does not the piston of the Galloway patent, to which you refer in your direct deposition, have internal water passages?

A. No; there are passageways in a plate carried by the piston, but none in the piston.

37 X Q. What is the function of those passages in the plate of the Galloway device?

A. They form ports for the steam. The patent says as follows: "To effect the proper admission and emission of the steam, there are five holes, *w w w w w* through the plate *o*, as seen in the plan view of the piston, figure 8."

38 X Q. What are the position and function of th einternal water passages in the structures of the Nash reissue and *and* how are *are* they arranged with relation to the piston?

A. The piston, as shown in figures 1 to 5, inclusive, shows the internal passageways in the piston. These are shown as two sets, receiving and discharging. The receiving passageway is at the

46 bottom of the piston; the discharging passageway is at the top of the piston.

39 X Q. What internal water passages are there in the piston of the Hersey meter, how are they arranged in relation to the piston, and what is their function?

A. In the Hersey meter the waterways through the piston are only used for the exhaust water and are situated in the center of the piston, the exhaust water flowing in through the bottom of the piston and out at the top of the piston.

40 X Q. You have testified in your direct examination that the distinguishing characteristics of the 4th claim of the Nash reissue is that it embodies as one element a piston having a free movement in the cylinder controlled only by the shape of the piston, the shape of

the cylinder, and the flow of water through the meter. What is the extent of the freedom of motion of the Nash piston?

A. It is practically perfectly free.

41 X Q. It is caused to travel in an absolutely fixed path, determined by its own shape and that of the case, is it not?

A. It does travel in such a path and this is a feature of its freedom.

42 X Q. Does the shape of the Hersey piston and of the case enclosing it have the same effect in determining the travel of that piston in a fixed path?

A. Yes; both follow their cases under the influence of the flow of water.

43 X Q. What keeps the Hersey piston up against the side of the case and in contact with it?

A. The water.

44 X Q. And is the same true of the Nash piston in the same way and to the same extent?

A. Yes.

45 X Q. What interferes with the freedom of motion of the piston of the Galloway patent?

A. The crank.

47 46 X Q. Has that crank a spring connection in the Galloway patent?

A. Yes.

47 X Q. You state that the 6th claim of the Nash reissue is distinguished from what is old in the art by the fact that an element of that combination consists of ports controlled by said piston itself in its motion within said chamber. How are those ports arranged with relation to the piston and what is its action in controlling the ports?

A. Referring again to figures 1 to 5, inclusive, which show this feature, the inlet port is formed in the bottom plate by an opening having peculiarly formed sides, which, as the piston moves about in the case, exposes the proper ports in the piston at the proper time, and the exhaust port is arranged in the top plate above the piston in the same way, and co-acts with the exhaust ports of the piston as the inlet port in the bottom plate co-acted with inlet ports in the piston, all acting in unison.

48 X Q. Do you find the same arrangement of ports in the Hersey meter as in the devices of the Nash reissue; if not, how do they differ?

A. I do not find precisely the same arrangement. In the Hersey meter the inlet ports are in the bottom plate, and instead of being formed by a polygonal opening, each portion of which acts as a separate valve, they are formed of separate holes. These holes let the inlet water into the cavities directly and not through the piston. The exit ports are formed both in the top and bottom plate of the meter, and the water exhausted through the bottom exhaust ports passes up through the piston. In both cases the movements of the pistons cover and uncover inlet and exhaust ports at the proper time, with the difference that all the water passes through the Nash piston and only some of the water through the Hersey piston.

48 49 X Q. Are you right in saying that the inlet ports of the Hersey meter are controlled by the piston?

A. They are closed by the movement of the piston, and I suppose this is what is meant by the word "control," and the water inlet and outlet is controlled by the piston, the plate, and the case.

50 X Q. What controls the ports in the Galloway device to which you have referred?

A. The position of a plate which is bolted to the piston and which operates on a surface outside of the cylinder.

51 X Q. It is true of the Hersey meter, is it not, that the motion of its piston is continuous, and that all parts of the piston partake of its motion to the same extent and at the same rate?

A. Yes.

52 X Q. It is true, is it not, that all forms of piston shown and described in the Nash reissue have a different number of projections from the number of cavities in the case, and that this must be true of all pistons having the compound motion which characterizes the structures of that reissue?

A. Yes.

53 X Q. Do you find the combinations of the 3d and 6th claims of the Nash reissue in the structure illustrated in figures 7 and 8 of the Nash reissue?

A. I do not.

54 X Q. Do you find in the structures illustrated in figures 7 and 8 the combination of mechanism forming the subject-matter of the 4th and 5th claims of the Nash reissue?

A. Yes.

55 X Q. Do you find any reference in the specification of the Nash reissue to the free movement of the piston in the cylinder which is referred to in the 4th and 5th claims?

A. I do not find the exact language of the claim in the
49 specification, but I refer to the 1st page, lines 42 to the end of the paragraph, line 55, 2d column, 1st page.

56 X Q. In what structures of the Nash reissue do you find the combination of mechanism set out in the 7th claim of that reissue?

Objected to as not being proper cross-examination, no question having been asked this witness on the direct examination in relation to said claim not being involved in the issue in this cause, and the witness is instructed that he need not answer the question unless the counsel for defendant will state on the record that he wishes to make the witness his own.

A. Figs. 3, 9, and 12 or the other views of the same structures only.

HENRY L. BREVOORT.

Adjourned till Thursday, the 7th inst., at 11 a. m.

50 NEW YORK, *June* 7, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of witnesses herein on behalf of complainant was continued.

JOHN C. KELLEY, being called on behalf of complainant and duly sworn, testifies as follows:

1 Q. What is your name, age, residence, and occupation?

A. John C. Kelley; 49 years of age. I reside in Brooklyn, N. Y., at 247 Hancock street. I am president of the National Meter Co.

2 Q. Are you president of the company complainant herein?

A. Yes.

3 Q. What meters by their trade names does your company manufacture themselves?

A. Crown, Empire, and Gem.

4 Q. I place in your hands Complainant's Exhibit A. Please state which, if either, of the meters referred to is manufactured and sold by you under these letters patent.

A. Crown meter.

5 Q. When did you first place the meter known as the Crown on the market?

A. I think we sent out a very few in the latter part of 1878.

6 Q. Please state in how many cities and towns in the United States the Crown meter is in actual use.

A. According to our books, four hundred and seventy.

7 Q. Please state the number of meters sold by your company, beginning with the 1st of January, 1879, and ending with the 1st of January, 1888, year by year.

A. In 1879, two hundred and seventy-two; in 1880, twelve hundred and fifty-six; in 1881, twenty-six hundred; in 1882, five thousand two hundred and thirty-two; in 1883, six thousand
51 nine hundred and ninety-eight; in 1884, seven thousand four hundred and six; in 1885, seven thousand four hundred and ninety-nine; in 1886, seven thousand seven hundred and sixty-six; in 1887, nine thousand four hundred and fifty-five.

8 Q. Please state as near as you can the total number of Crown meters sold by your company to the 1st of June, 1888.

A. Fifty-one thousand six hundred and sixteen.

9 Q. Please state the names of some of the principal cities and towns in which the Crown meter is used and the number of meters in use in each of said towns respectively.

A. I will give it as near as I am able. It will be very nearly correct. New York city, nine thousand; Providence, R. I., four thousand; Hoboken, N. J., two thousand; Pawtucket and Central Falls, R. I., being under one management, two thousand; Fall River, Mass., seventeen hundred; Boston, Mass., sixteen hundred and fifty-five; Atlanta, Ga., eleven hundred; Yonkers, N. Y., eleven hundred; Rochester, N. Y., one thousand; making a total in those nine places of twenty-three thousand five hundred and fifty-five.

10 Q. If you can, give me the names of the principal water meters now on the market.

A. Worthington, Balls & Fitts piston, Duplex piston, Union rotary (the three last named are all made by the Union Water Meter Co., of Worcester, Mass.), the Desper meter, the Thomson meter, Shedd meter, the Balance valve, Hersey, Gem, Empire, Equitable,

and the Tremont. The Gem and Empire are made by the National Meter Company.

11 Q. Are there or are there not numerous other meters which have a limited sale?

A. There are a few which have a very limited sale.

12 Q. What water meter other than the Crown has had the largest sale? And state approximately the number of such meters sold.

52 A. The Worthington; probably forty thousand have been sold. The meters which have the next largest sale are those manufactured by the Union Water Meter Company (of which there are three different styles sold under the names of Ball & Fitts piston, Duplex & Union rotary), of which, all told, there have been between twenty and twenty-five thousand sold.

13 Q. How long has the Worthington meter been upon the market?

A. The patent was granted in 1855. I understand that the meter was put on the market very shortly after the patent was granted. I first saw the Worthington meter in the year 1869, a few months prior to the organization of our company, which was the first time I became connected with the water-meter business, and I understood at that time that it had been on the market for a long time.

14 Q. How does the price of the Crown meter compare with the price of other water meters on the market?

A. I think it is about the highest-priced meter in the market, according to sizes. On the larger sizes the Crown is decidedly more expensive than the Worthington. On the smaller sizes the Crown is only slightly more expensive than the Worthington, there being a difference of not more than one or two dollars in selling price per meter. I think this statement is pretty nearly correct. The great majority of meters sold are from one-half inch to an inch in sizes. The great difference in selling price does not appear till after the inch size.

All the questions and answers from and after interrogatory 6 and the answer thereto objected to as incompetent, irrelevant, and immaterial, and it is agreed that said objection shall apply to all such questions and answers as if repeated after each of them.

53 16 Q. When was the Hersey meter first put upon the market?

A. I don't really know. I think it was in the fall of 1885. I don't think I saw a Hersey meter till 1886.

17 Q. I understand that you have a very large number of Crown meters, something about nine thousand, in use in New York city. Have you any communication from the chief engineer of the Croton aqueduct of recent date relating to these meters?

Objected to as incompetent, irrelevant, and immaterial.

A. I have a copy of a letter which I received from the chief engineer of the Croton aqueduct, dated May 2, 1888.

Copy of said letter produced and offered in evidence and marked Complainant's Exhibit F, Birdsall letter, June 7, 1888.

Same objection as to question.

18 Q. Have you within a recent date received from any of the departments in which large numbers of Crown meters are in use detailed reports certifying to tests made officially by such departments? If so, please produce them.

Same objection.

A. I have and I now produce them. One from Providence, R. I., dated April 20, 1888; one from Hoboken, N. J., dated May 11, 1888; one from Fall River, Mass., dated March 30, 1888; one from Rochester, N. Y., dated May 10th, 1888.

Said four reports offered in evidence and marked respectively Complainant's Exhibits G, H, I, and J, June 7, 1888.

Same objection to all said exhibits.

54 19 Q. Referring to the specification of the patent in suit, I find in a disclaimer immediately before the claims a reference to an English patent of Elijah Galloway, December 14th, 1846, No. 11485. When did you first see or hear of the existence of that patent?

A. I am under the impression that it was about a month or six weeks prior to our first calling on you, the latter part of September or during October, 1886, I first heard of the patent. I think I first called and formed the acquaintance of your firm (Broadnax & Bull) about the 10th of November, 1886.

21 Q. Are you or are you not confident that you did not hear of or see the Galloway patent or the structure therein described earlier than the 1st of August, 1886?

A. I am.

12 Q. What steps did you thereafter take to ascertain the effect of the existence of that publication upon the Nash patent of January 21st, 1879, being Exhibit B in this case?

A. I received that patent in a communication from Johnson & Johnson, of Washington, and called Mr. Nash's attention to it, and we then decided that we had better have some New York counsel to advise with, and the firm of Broadnax & Bull being recommended to us as a reliable firm, we decided to call on them and submit the Nash patent and the Galloway for examination and ask for their opinion in reference to it.

22 Q. As the result of the advice you obtained from them, did you or did you not instruct them to apply for a reissue of the original patent?

A. I did.

23 Q. You have said that you first saw or heard of the Galloway patent or structure through a letter from Messrs. Johnson & Johnson, of Washington, inclosing a copy of the Galloway patent. What relation has the National Meter Co. with the firm of Johnson & Johnson?

A. They are our patent solicitors in Washington, and have procured for us a great many patents.

55 24 Q. State, if you know, how they happened to send you at that time a copy of this patent.

Objected to as incompetent, irrelevant and immaterial.

A. I believe they wrote that in making an examination for some other case they discovered this patent and sent us a copy of it.

Cross-examination:

25 X Q. Were you familiar with the Hersey meter at the time when the Galloway patent was first brought to your attention?

A. I had seen the Hersey meter prior to that time.

26 X Q. During your consultations with Messrs. Broadnax & Bull, which resulted in your reissue of the Nash patent here in suit, did you consider the Hersey meter and its relations to the Galloway structure, and to the Nash patent which you reissued, on which reissue this suit is brought?

Objected to, 1st, on the ground that the witness was not produced, nor has he been examined as an expert either on mechanical structures or on patents, and because, in fact, he is not an engineer or mechanic and does not pretend to have any special knowledge in relation to those subjects; and, 2d, on the ground that it is the obvious intention of defendant's counsel, by his question to call forth information in the nature of a privileged communication; and complainant's counsel instructs witness that defendant's counsel has no right to question him concerning any communication which passed between him and his counsel, and whenever it is necessary to answer counsel's cross-question to state the contents of such communication he is at liberty to refuse and he is instructed to do so.

56

A. I should answer that question in this way: that we submitted the documents to Broadnax & Bull, and without giving special attention to the details I was governed by their advice and proceeded to get the reissue patented.

27 X Q. Did you consider the Hersey meter during those consultations?

A. I only informally looked at it. I did not consider it, not being a mechanic or an engineer.

28 X Q. Did you furnish your counsel, Messrs. Broadnax & Bull, a Hersey meter or did they have one during the time preceding the reissue of the Nash patent and subsequent to your calling upon them with reference to the questions raised by your discovery of the Galloway patent?

A. We did furnish them one.

29 X Q. Was one of your purposes in consulting Messrs. Broadnax & Bull to determine whether or not you had any claim under the Nash patent in view of the Galloway structure against the Hersey meter?

Objected to as being indefinite.

A. It is not exactly in that shape that I can answer it. Our purpose was to find out just exactly our position under that patent.

30 X Q. Do you mean your position under that patent as far as the question of its infringement by the Hersey meter was concerned?

A. I mean just this: We had not the slightest doubt but what the Hersey meter infringed our original patent (Exhibit B) up to the time of receiving the copy of the Galloway patent from Messrs. Johnson & Johnson.

31 X Q. And was your purpose in consulting them to find
57 out if the prior existence of the Galloway patent affected in any way your rights against the Hersey meter under the Nash patent?

A. Our purpose was to find out just exactly how we stood.

32 X Q. How you stood with reference to the Hersey meter, among other things?

A. Yes.

Question *de bene esse.*

33 X Q. It is the fact, is it not, that you have received reports of tests of the Crown meter in which the results were not as favorable as those indicated in the copies of the letters which you have introduced in evidence and marked Exhibits F to J, inclusive?

A. We have not received copies of tests, but we have heard of instances where they did not give as good results. All the official records of tests that we have received recently were about the same character as the exhibits.

34 X Q. Did Mr. Nash ever inform you that he knew prior to August, 1886, of engines or meters having substantially the same arrangement of piston and case as that of the Galloway patent?

A. No.

JOHN C. KELLEY.

Complainant rests.

58 U. S. Circuit Court, Southern District of New York.

THE NATIONAL METER CO.
vs.
BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS. } In Equity.

Testimony on behalf of complainants for final hearing, in rebuttal, taken before S. M. Hitchcock, one of the examiners of this court, pursuant to the 67th rule of the U. S. Supreme Court, in equity, as amended.

NEW YORK, *Sept.* 25, 1888.

Met pursuant to notice.

Present: J. Edgar Bull, Esq., on behalf of complainants and F. P. Fish, Esq., on behalf of defendants.

HENRY L. BREVOORT, being called on behalf of complainants and duly sworn, testifies as follows:

1 Q. Are you the same Henry L. Brevoort who has heretofore testified in this case on behalf of complainants?

A. I am.

2 Q. Have you read the deposition of Henry B. Renwick, John P. K. Otis, James Bennett Forsyth, and James A. Tilden, taken on behalf of defendant in this cause?

A. I have.

3 Q. Is, in your opinion, the principle, purpose, and mode of operation of the meter marked Exhibit D, the same being de-
59 fendant's meter, substantially similar to or substantially different from the meters of the patent in suit?

A. I think the defendant's meter referred to in the question is a meter substantially the same in principle as the meter described in the patent in suit. I have made a wooden model which I now produce and which will serve to illustrate the similarity in principle of the two meters. This model represents a cylindrical case and a cylindrical piston with the projections from the case and the projections from the piston left off, so that the metering chambers are not present. I now take this model in my hand and I sweep the piston round the case, allowing the handle by which I move it to rotate in my hand, and in doing this I illustrate, in a simple form, the displacing action of the Nash meter. With the same apparatus I will now illustrate the displacing action of the defendant's meter, and to do this I cause the piston to sweep in the same way around the case, but I hold the handle and I prevent the rotation of the piston on its centre, and it will be seen that in doing this the pis-on sweeps through the same space within the case as it did when it was allowed to rotate on its own centre.

Of course, in the defendant's meter the piston does not rotate on its own centre, while in the Nash meter the piston does rotate; but this difference, in view of the state of the art, I think, is immaterial, as I said in my direct examination. Referring to the Galloway 1846 engine and the book "Kinematics," these two exhibits show that rotating and non-rotating pistons were both known in the state of the art before either Nash or Tilden produced the meters here in controversy, and upon either of these old forms the inventions of Nash were applicable.

I now produce a model of the thing shown in the book "Kinematics." It will be seen that this shows a piston moving about in a case, the piston having one less projection than the case, and
60 that, in substance, this illustrates the principle upon which Nash worked in constructing his meter, while, on the other hand, the defendant's meter started out on the principle of the Galloway patent 1846 engine, but was made into a successful meter by the inventions that Nash applied to the form of engine with which he worked, to wit, the Galloway Kinematic engine. Now, with this state of the art I fail to see that the difference between the two meters is a difference in principle, for both started from sources which were

known equivalents, and the application of the Nash inventions to the Galloway 1846 engine was a matter that any mechanic could accomplish after seeing what Nash had done. Consequently I think that the two meters are substantially alike in principle and in mode of operation.

Diagrammatical model referred to in the early part of the foregoing answer and produced by witness is offered in evidence and marked Complainant's Exhibit "Brevoort Diagrammatic Model K, Sept. 25, 1888."

The model of the thing shown in the book "Kinematics" and produced by witness is offered in evidence and marked Complainant's Exhibit "Brevoort Kinematic Model L, Sept. 25, 1888."

4 Q. Referring to Exhibit Brevoort Diagrammatic Model K, what, if any, difference is there between the displacing actions of the piston when the button attached thereto is permitted to turn as the piston sweeps around the case and when it is held fast and not permitted to turn as the piston sweeps around the case, these being the two conditions referred to in your last answer?

A. There is no difference in the displacing action, the piston in both conditions passing through the same space and displacing the same quantity of fluid.

61 5 Q. If you have caused to be made any model to illustrate the fact that the displacing action of a piston rotating on its own centre and one not rotating on its own centre is substantially the same or any model illustrating the fact that the principal, purpose, and mode of operation of Exhibit D and the meters of the patent in suit are substantially the same, please produce them.

A. I have caused to be constructed a meter case and two sets of heads. The other case which I shall use for the purpose of illustration is the defendant's meter and its piston. I now take case marked M, with its heads, and the piston from defendant's meter D. I also take the defendant's meter. I put in it a piston with the Nash portage, as shown in the patent, and I put upon this meter the two head plates, as shown in the Nash patent.

The metal meter case and heads referred to and produced by witness are offered in evidence and marked Complainant's Exhibit "Brevoort Model M, Sept. 25, 1888."

The piston produced by witness is offered in evidence and marked Complainant's Exhibit "Brevoort Model N, Piston," Sept. 25, 1888, and the head plates made to co-act with the said piston when attached to the case of defendant's meter are offered in evidence and marked Complainant's Exhibits "Brevoort Model N, Head Plates," Sept. 25, 1888.

It will be seen by operating the piston of this meter, model N, by hand that the piston does not rotate on its own centre, but moves in the case as does the piston of defendant's meter, and it will be seen that this movement is accomplished by openings or ports which are the same, substantially, as those shown in the Nash patent. The

other meter, the case of which is marked M, now has in it the
62 piston taken from the defendant's meter, and by operating it by hand it will be seen that the piston moves about in the case, and in doing so that it rotates on its own axis; and by examining the head plates it will be seen that the meter has substantially the portage of the defendant's meter. I have tried these two meters and I know that they will operate.

These illustrative exhibits, I think, clearly show and demonstrate the fact that the rotation of the piston on its own axis is not a point of difference that is either substantial or material, for they show that one form with one kind of portage and the other form with the other kind of portage can be successfully used. In view, also, of the state of the art, which discloses both forms of engine, the difference appears to me between the Nash and the defendant's meters, so far as the rotation of the piston goes, to be one which is not substantial, but merely one of form and arrangement, the Nash inventions being applicable to either form; and both forms, as I have before said, are shown by the state of the art to have been known in the shape of engines, and in this connection I again call attention to the Galloway 1846 patent and the book "Kinematics."

6 Q. Can you produce an illustrative model adapted to show the operation of a piston which does rotate on its own centre and one which does not rotate on its own centre in the same enclosing case?

A. I can. I produce two wooden illustrative models, both apparently illustrating defendant's meters, or meters with pistons which do not rotate on their own centres.

The models are offered in evidence and the two cases are marked respectively "Brevoort Model O" and "Brevoort Model P," and the two wooden pistons are marked respectively "Brevoort Model Q" and "Brevoort Model R," all of Sept. 25, 1888.

63 To show this I place the piston R in the case O and the piston Q in the case P, and it will be seen that the two pistons move as do the pistons in the defendant's meters, controlling the ports properly. I now take the piston R from the case O and replace it by the piston Q, and it will be seen that the piston rotates on its own centre and moves about the meter case as does the piston of the Nash patent, properly controlling the ports. The portages in both cases are the defendant's form, and these ports operate when either of the pistons are in the case O, and also when the piston Q is in the case P and when the piston R is in the case O. These models show the fact that there is no substantial difference between the piston that rotates on its own centre and the piston that does not rotate on its own centre.

7 Q. Mr. Renwick has testified that, in his opinion, the device shown in figure 10 of the patent in suit will not go round if attached to central spindle, as shown in the patent. Do you agree with Mr. Renwick?

A. I do not. I now produce a meter which is in all material respects like the drawing of the patent, figure 10, and which meter I have operated successfully, and I think this is demonstration of the

fact that the style of meter shown in the patent at figure 10 is operative and will go round, notwithstanding Mr. Renwick's statement as to his opinion of its operation.

Meter produced and offered in evidence and marked Complainant's "Exhibit Brevoort Model S," Sept. 25, 1888.

8 Q. Mr. Renwick has testified that, in his opinion, the centre of the piston shown in figure 11 of the patent in suit will describe small arcs with their concave surfaces out, and not a circle. If you have a meter constructed substantially as shown in that figure please produce it and ascertain what figure the centre of the piston describes.

64 A. I now produce the meter like figure 11, and I place the lead of a pencil in the centre of the piston and rotate the piston with a piece of paper in the bottom of the meter case upon which the pencil traces the path followed by the centre of the piston, and it will be seen that the centre of the piston draws a circle on the paper. This, I think, refutes Mr. Renwick's statement that the pencil would draw small reverse arcs.

Model produced and offered in evidence and marked Complainant's Exhibit T, Sept. 25, 1888.

9 Q. Mr. Renwick has stated that the pressure of the water passing through the defendant's meter will take up wear, so that the meter will be as accurate after some wear as it was before, and he has stated that the pressure of water passing through the meter of the patent in suit cannot have this function, and that consequently the accuracy of that meter is secured merely by the fit of the parts. Please state whether you agree with Mr. Renwick in this matter.

A. I do not agree with Mr. Renwick, and I think that the Nash meter will take up the wear. I now produce a meter which I am informed has been used a long time.

Said meter offered in evidence and marked "Complainant's Exhibit U," Sept. 25, 1888.

This meter shows wear on the piston and also wear upon the points of the case, showing that in operation the water has carried the piston in the case in contact on the one side with the point of the case and on the other side in contact with one of the minor projections of the piston and case, so that, although the piston is loose in the case, contact is made by holding the point of the piston up to the point of the case on one side, while on the other side

65 one of the minor projections from the piston slides upon the side of one of the projections from the case. It is difficult to explain this action in words and I refer to a recent patent taken out by Mr. Tilden, dated July 10, 1888, No. 385,970, which in an exaggerated form explains how the Nash meter keeps tight. In this patent the diagrams and the explanation will show clearly why the Nash meter keeps tight. I have seen this meter, Exhibit U, in operation and it works satisfactorily. The patent of Tilden to which I have referred has heretofore been put in evidence in this case. I

have tested this meter, Exhibit U, and the difference between a given quantity of water with a full stream and an eighth of an inch stream was only about two pounds.

10 Q. Mr. Renwick has testified that the acting points of the piston shown in the patent in suit describe epicycloidal figures about the center of the enclosing case. He has also testified that the movements of the devices shown in the book "Kinematics" are substantially the same as the movements of the pistons of the patent. Please state what figures are described by the several parts of the "Kinematics" device, and state what significance, in your opinion, attaches to the fact that epicycloidal figures surrounding the center of the case are described by the acting points of the pistons of the patent.

A. The device in the book "Kinematics" when operated shows a piston which moves in concentric circles—that is, any point on the piston makes a circle concentric with any other point having a different radial location, while the case describes at any given point small circles which are not concentric with each other. Now, in this mechanism the outer portion has the same movement that the piston of the defendant's meter has, and if the outer portion is held and the device operated the piston has the same movement as that of the Nash meter, showing that in the same mechanism the
66 movements of both meters are present. The statement that the meters in the Nash patent describe what Mr. Renwick calls small epicycloidal curves is tantamount to the statement that the pistons in these meters revolve on their centres.

11 Q. What figures are described by a point on the periphery of the piston of Exhibit Brevoort Diagrammatic Model K—first, when the button is held firmly and the piston while it sweeps around within the case is not permitted to rotate on its own centre, and, second, what figure is described by the same point when the button of the piston is permitted to turn as the piston sweeps around within the case, the piston in this instance rotating on its own centre?

A. In the one case, when the piston is allowed to revolve on its own centre a point on the periphery forms epicycloidal curves. When the piston is held but swept around the case it makes a circle—that is, when the piston is held so that it does not rotate on its own centre. In this illustrative model the epicycloidal curves surround the centre of the meter case and the small circles which are made when the piston is kept from rotating on its own centre do not surround the centre of the case except the one that is made by the centre of the piston.

12 Q. Mr. Renwick has testified that, in his opinion, neither the piston of defendant's meters nor the pistons of the meters shown in the patent in suit have any motions which may properly be designated "eccentric motion." Do you agree with Mr. Renwick?

A. I do not, and I have made some models which will illustrate my views on this point. I take the wooden illustrative exhibit marked Exhibit P and I place it in a suitable piston with the same number of projections as there are in the case, and I then through

the centre of the case slip the shaft carrying an eccentric pulley on it, which pulley fits a hole cut in the centre of the piston. I now rotate the shaft of the eccentric pulley, and it will be seen
67 that the piston has the same motion that it would have if it was guided by the walls of the case alone, thus showing that the movement of the piston is truly eccentric and that its motion is the same, substantially, whether it follows the outside walls of the case or whether it is driven by an ordinary eccentric.

Piston and eccentric produced by witness are offered in evidence and marked respectively "Complainant's Exhibit V, Piston," and "Complainant's Exhibit V, Pulley," Sept. 25, 1888.

I now take the piston which has just been marked with the letter V out of the case that I used to represent the defendant's case, to wit, the case marked Exhibit P, and I place the same piston in the case marked Exhibit O, which has one more projection than the piston and which represents for the purposes of this illustration the Nash case, and I place in the same way as I did before an eccentric pulley provided with a suitable shaft in the piston, the shaft passing through the centre of the case, and I then rotate the shaft and it will be seen that the piston moves as does the piston in the Nash meter, rotating on its own centre and sweeping around the case as the meter would operate in practice, and that this motion is obtained by an ordinary shaft and eccentric pulley, the piston fitting the case substantially as though it ran against the walls thereof.

Pulley last produced offered in evidence and marked "Complainant's Exhibit W, Sept. 25, 1888."

These two exhibits clearly show that the motion of the piston either in the defendant's or in the Nash meter are both eccentric motions; that the pistons move when driven by an eccentric with the same motion they would have if they ran against the in-
68 terior of the case, the pistons in the illustrations which I gave being merely straps surrounding an eccentric pulley and moved in eccentric motions thereby. The eccentric pulley Exhibits V and W are such as might be found on almost any steam-engine, and they operate in the same way and have the same motion as ordinary eccentrics have. I think a thing that is directly driven by the motion obtained from an eccentric pulley must be said to have eccentric motion, and for this reason I think that the pistons in both the defendant's and the Nash meter have eccentric motions.

13 Q. In the patent in suit I find the term "compound motion" employed. What do you understand this term to refer to as distinguished from the term "eccentric or side-rocking motions" employed in the specification and claims?

A. I understand that the compound motion referred to is the motion that the piston has when it is both sweeping around the case and rotating on its own center. Thus, I put the piston marked Q into the case marked O and move the piston around in that case, the case having one more projection than the piston. It will be

seen that the piston partakes of two motions, one a motion around the case, and the other a motion around its own centre. Now, these two motions are what the patent refers to as the compound motion of the piston.

The same compound motion can be shown with Exhibit K. When the piston of this exhibit is moved around on its case and the handle is allowed to turn in fingers, it will be seen that the piston partakes of two motions. One is the motion around the case, and the other is the motion of the piston around its own axis, and these two motions together form what I understand the patent refers to by the "compound motion."

I will now illustrate what I understand the patent means by the eccentric or side-rocking motion, and to do this I will again refer to Exhibit K, but I will hold the piston and prevent its rota-
69 tion on its own axis. Now, as I move the piston around in the case it will be seen that its motion is that of an eccentric, and this can also be illustrated by taking the case P and putting in the eccentric V and piston V, when it will be seen that a simple eccentric motion is had and not a compound motion. To illustrate the compound motion again I will put the piston V in the case O and place the eccentric W in position, when it will be seen that the piston has a compound motion—that is, an eccentric motion and a motion of rotation on its own axis.

14 Q. Which, if either, of the motions described is known to mechanics as a motion of translation and which, if either, as a motion of rotation?

A. The compound motion in which the piston moves around in a case and also turns on its own centre involves both a motion of rotation and a motion of translation—that is, I take the model Exhibit K and I move the piston round in the case, allowing the piston to rotate on its own centre. Now, this compound motion involves both the motion of rotation and the motion of translation. I now hold the centre of the piston so that it does not rotate on its own center and I cause it to sweep around the case, and when I do this I merely have the motion of translation without any rotation. The motion of translation consists in the bodily moving about in space of the piston, while the motion of rotation merely is descriptive of the turning of the piston on its own centre. In speaking of a motion of translation the centre of the mass is the point of the moving body that is considered.

15 Q. Referring to model K, is or is not the motion of translation of the piston the same when the piston is allowed to rotate on its own centre while it sweeps around the case as when the pis-
70 ton is not permitted to rotate around its own center while it sweeps around the case?

A. The motion of translation is the same in both conditions.

Adjourned till Wednesday, the 26th inst., at 11 a. m.

WEDNESDAY, *Sept.* 26th, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Mr. BREVOORT was continued as follows:

16 Q. Mr. Renwick has testified that the Galloway 1846 patent has a free piston, controlled only by the shape of the piston, the shape of the cylinder, and the flow of water through the meter. Is this, in your opinion, correct?

A. It is not; and I will give my reasons for this statement which I make. The Galloway engine has in it a piston of the shape of the defendant's piston, and this piston is within a cylinder or case closely resembling the case internally of the defendant's meter. The piston, however, has attached to it a plate circular in shape and larger in diameter than the piston. This plate is provided with port openings, and so far as this discussion goes may be considered as one piece with the piston, as the plate partakes of all the movements made by the piston. Outside of what may be called the case or cylinder of the engine is what I will refer to as a valve face, and upon this valve face the under side of the cylinder head plate, as I may call it, slides. The head plate of the cylinder is of sufficient size to always rest upon the valve face, which is made as a part of the cylinder, and at right angles to the vertical walls thereof.

As the piston moves about in the chamber this plate moves
71 with it and its ports co-operate with the ports in the valve about face, which ports are outside of the cylinder chamber, and as the piston sweeps around in the case this cylinder-head plate sweeps around on its valve face. The piston itself has what might be properly termed a crank running through it, and this shaft or crank-pin moves about with the piston as it describes its eccentric movement within the case. This shaft is provided with a piece pressed out by a spring, the moveable piece being a portion of the shaft that penetrates the piston, and the object of the spring and moveable piece of metal "is to ensure the necessary contact between the segmental surfaces of the piston and those of the cylinder or receiver."

I take the above from the patent, as the quotation marks show. Now, I think that the piston cannot be said to be free, because in all its movements it necessarily has to carry with it this head plate, and instead of being free it is hampered by the inertia and friction of the head plate, and this necessarily takes away from the piston that freedom of movement which I understand the piston of the Nash patent is to have. Neither can it be said that the piston of Galloway is uncontrolled, for according to the specification the spring in the shaft which penetrates the piston is to, in a measure, control it. The spring, to perform the offices referred to in the patent, must have power enough to move the piston, and this the spring in the model will not do, even when the parts are oiled. I fail to see that the spring would be of any use or would perform the functions assigned to it in the patent, unless it was strong enough to accomplish the purposes set forth in the specification, which neces-

sarily involves a movement of the piston by the spring The spring in the model would not move the piston and its head-plates when the surfaces were lubricated even, and in a meter the surfaces
72 cannot be greased. The use of the Galloway spring, if strong enough to perform its functions, also introduces another element, and that is, increased friction between the piston and the parts against which it moves, and this friction would be fatal, probably, to a meter.

17 Q. Do you regard the spring in the sha- of the Galloway engine essential to the proper operation of that engine?

A. I should say it was. In starting the engine it is necessary that the piston should be in contact with the walls of the cylinder case, and this the spring, if properly made, would ensure. If the engine "chattered," as Mr. Renwick suggested, I should think the spring would be useful in preventing this action. The spring in a Galloway engine is necessarily heavier by reason of the cylinder head plate than it would be if no such head plate were present, for this plate adds both weight and friction to the movement of the piston, and this the spring has to overcome over and above the weight and friction of the piston itself.

18 Q. Would a spring like that shown in the Galloway patent be of advantage or disadvantage if applied to the piston of defendant's meter?

A. A spring of the nature of that used in the Galloway engine would be a great disadvantage if applied in a meter. Such a spring would increase the friction, and any increase in the friction of the piston's movements would be accompanied with an increased leakage; also any friction introduced in the piston's movement would decrease the water pressure on the exhaust side of the meter. In an engine the spring would tend to make the piston fit tighter, especially if the piston chattered, as suggested by Mr. Renwick. In an engine the steam is received at a certain pressure and the object of the mechanism is to utilize as much of this pressure as can
73 be utilized and to discharge the steam at as low a pressure as is possible. With a water meter, on the other hand, the object is to deprive the water of as little of its pressure as possible and to have the pressure on the exhaust side and on the inlet side as nearly the same as they possibly can be. Consequently the two devices, starting with different requirements, necessarily have different relations of parts to adapt them for the ends sought in the two cases. Thus a piston of an engine is advantageously packed so that steam cannot pass it. This imposes friction, but it is better to have the friction than a leak. In a meter it is desirable to have the piston so free that it would rather move with the water instead of letting the water leak past it.

19 Q. What do you understand to be the requirements of a piston of this class with reference to freedom?

A. I understand that the piston must be free in the full sense of that word. The piston must move so easily that it would register the finest stream of water that would leak past if the piston were held stationary. In a meter, as I have before pointed out, the pis-

ton must move sooner than allow the water to leak past it. With a steam-engine the parts must fit so tightly that there is no leakage. With a meter the piston must move so freely that when the water tries to leak past it cannot do so without at the same time moving the piston, and this result can only be accomplished by having a free and unobstructed and uncontrolled piston.

To illustrate the freedom of fit of the pistons of the complainant's and defendant's meters I took one of each manufacture and blocked the piston so that all the water that passed had to leak by the piston, and I found that in both cases this leakage amounted to about one-third to one-quarter of the amount that the meter would pass with a full stream with an unobstructed piston. In this ex-
74 periment I first took each meter and ran it a minute with the pistons unobstructed and on a full steam and weighed the water. I then did the same thing with each meter and with the piston blocked, and I found that with the pistons blocked the above amount leaked past. This experiment shows the looseness of fit that exists between the piston's head and case and which is requisite to obtain the necessary freedom of movement of the piston in the case, both the complainant's and the defendant's meters, in this regard, being substantially alike. With pistons fitted so freely the water would leak around were it not for the fact that when the water attempts to leak the piston prefers to move rather than let the water pass it, and thus the freedom of the movement of the piston is a cure for what would naturally be supposed to be a serious source of leakage.

20 Q. Have you examined the patents to Read and the patent to Fitts, both of record? If you have, please state whether you find that the pistons in the meters of those patents are or are not supported on central spindles.

A. I have examined the patents. The pistons in both cases have central bearings or spindles.

21 Q. Are the pistons of either complainant's or defendant's meters supported on central spindles?

A. No.

22 Q. Please state what, in your opinion, are the advantages or disadvantages of having the pistons in the type of meters referred to in the last question made of hard rubber and of metal.

A. In the meters enquired about in the question the pistons, being without any pivotal or central supports, are called upon to slide about on the lower head plate of the meter. In this way the maximum amount of friction exists between the pistons and the cases that can be had between two bodies occupying such relationship one to the other. To give the requisite freedom of movement
75 it is necessary to diminish the friction to the lowest point, and this can best be done by making the pistons of rubber. The lightness of rubber decreases the pressure between the piston and the bottom of the head of the case, and the rubber can slide about with but little friction on that surface. In the case of the Fitts and the Read patents the pistons are journaled and their lightness to avoid friction is not so much a matter of moment as the fric-

tion is diminished by properly made and properly fitted journals. In meters of the class to which the Nash and defendant's meters belong the lightness of the piston takes the place of the carefully fitted journal of the meters like Fitts and Read, and in the first-mentioned meters the accuracy is much increased by the lightness and free movement of the piston, and this is not so to any large extent in the Fitts and Read meters. In those meters the piston are required to fit between metallic surfaces whose distance is always alike and the pistons must not change their size, for if they should swell the meters would stick, and as rubber changes materially it is not a substance which is adapted especially for such classes of meters, whereas in meters like the complainant's and defendant's rubber is specially adapted for a substance out of which to form the piston, for in these meters the freedom of fit enables them to operate even though the pistons swell slightly.

23 Q. What would be the value of defendant's meter, in your opinion, if provided with a metal piston like that shown in the Defendant's Exhibit Galloway Machine?

A. I should think that the meter would be absolutely valueless.

24 Q. Referring to the 5th claim of the patent in suit, please state whether, in your opinion, the fact that hard rubber pistons were employed in meters such as are described in the Read and Fitts patents of record anticipate said claim, in view of the state of
76 the art shown by the Galloway 1846 engine and the Galloway engine described in "Kinematics"?

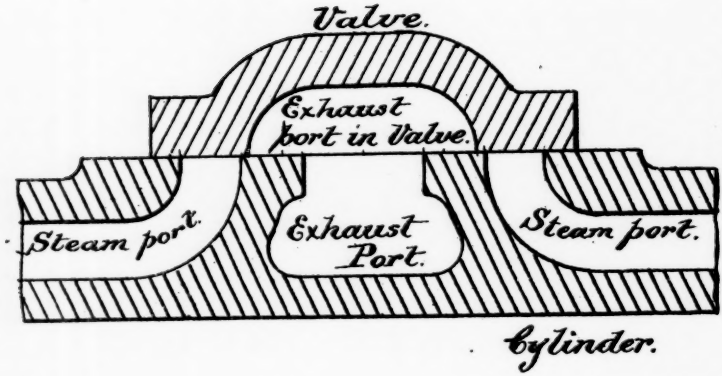
A. Even in view of the Galloway 1846 engine and the device shown in the book "Kinematics of Machinery," I am of the opinion that the Fitts and Read patents do not show the invention of the 5th claim of the patent in suit. I do not understand the 5th claim to cover broadly a rubber piston or a rubber piston like Galloway's metallic piston, with its controlling mechanism and the cylinder head plate. The claim, as I understand it, is limited to the piston of the 4th claim when made of hard rubber—that is, to a piston whose movements are free and controlled only by the shape of the piston, the shape of the cylinder, and the flow of water through the meter. A piston of this kind is clearly distinguishable and is a different thing from a piston which is carried by a central shaft, and I do not understand that the claim attempts or seeks to cover a hard-rubber piston other than one having the features and qualifications set forth in the fourth claim.

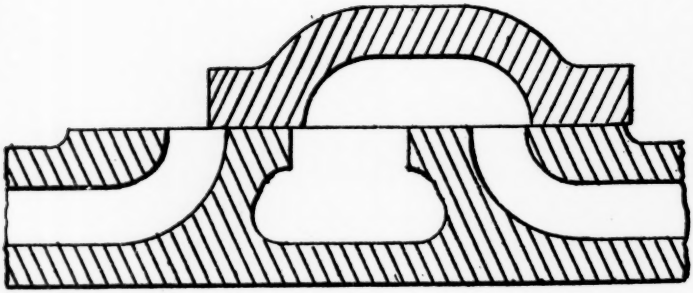
25 Q. Referring to the meter described in the patent to Fitts and Read of record, what would be the effect upon the accuracy or utility of that meter if by wearing on its spindle or by the expansion of the piston the edge of the piston came in contact with the meter case, and this even were the piston made of hard rubber?

A. The result would be that the meter would cease to register correctly and it would be valueless for the purposes for which it was made.

26 Q. Compare the meters of the class to which defendant's and the meters of the patent belong with those of Fitts and Read in respect to the particulars referred to in the last question.

Exhibit Z





No. 192.
National Meter Co.
vs.
Bd. Water Comrs
} p. 78.

A. In the meters of Fitts and Read the pistons are journaled and carried by shafts, and if the journal wears or the piston expands the cases and the piston will come in contact during some part of the revolution, and the result will be that the meters will not
77 register correctly. Now, in the Nash and in the defendant's meters no journals are used, and the pistons bear with their full weight always and at all times upon the bottom of the case, and no amount of wear can cause them to bear any harder upon the case, and the pistons are sufficiently loose in the case to admit of the changes that take place in the rubber being had without causing the pistons to jam. Where a device is carried by a shaft and is required to make a fairly close fit wear in the journal is always liable to bring the parts so carried into contact in some part of its revolution with the case. This danger is not present in the complainant's or the defendant's meters.

27 Q. Do you agree with Mr. Renwick in his statement that the ports of defendant's meter are controlled by the piston itself?

A. I do; his statement is correct.

28 Q. Mr. Renwick has criticized the use in the patent in suit of the term "ports" as applied to the central opening bounded by small arcs in the top and bottom end plates of the meters shown in said patent. Do you agree with him in his statement that these central openings are not ports?

A. I do not agree with him. The central openings certainly are ports, and I fail to see any reason why they should not be called ports, which term seems to me the proper name to apply to these parts.

29 Q. Mr. Renwick says that the end plates of the meter of the patent are, properly speaking, valves which control ports of the piston. Assuming this to be the fact, what effect, if any, does this have upon the opinion expressed in your last answer as to the propriety of these openings being called ports?

A. I do not see that it affects the question. Mr. Renwick has differentiated things by name rather than by their functions. The moving part of the device is usually called a valve, and the valve is very often provided with a port or ports, as in the case of
79 the ordinary slide-valve, a drawing of which I produce, showing the slide-valve in two positions, Fig. 1 showing it central and Fig. 2 showing the port in the valve connecting one of the steam ports with the exhaust port. Where two openings co-operate the opening that moves, or the structure in which the opening is, is generally called the valve. The pistons in these meters of the complainant's and defendant's may be termed rotary slide-valves containing ports, as do ordinary slide-valves.

Said drawing offered in evidence and marked "Complainant's Exhibit Brevoort Illustrative Drawing Z, Sept. 26, 1888."

(Here follows diagram marked p. 78.)

30 Q. Mr. Renwick has pointed out the fact that in the meter of the patent there is a large central opening in the head plate, and

there are a plurality of separate openings in the piston, while in defendant's structure the large central opening is in the piston and the plurality of separate openings are in the head plate. Assuming this distinction to exist, what, in your opinion, is its practical significance?

A. I don't see that it has any practical significance. It merely amounts to turning the mechanism around and using the same parts but altering their location. I produce a drawing, the upper figure of which shows a large opening in the piston and the small openings in the case, as has the defendant's meter. The drawing in the middle of the sheet shows the large opening in the case, and the small openings in the piston, as has the patented meter. The lower drawing, which does not attempt to distinguish between piston and case, has the same openings as appear in both of the sketches above and it is true of either meter, depending on which part is the movable part. I think this shows the fact that defendant's meter is not substantially different from the meter of the patent in this regard. In the drawings the small passages, as indicated by the words "to measuring chamber," in both lead
80 to said chamber, while the large passages in both lead to the exhaust, as indicated by the word "exhaust."

Said drawing offered in evidence and marked "Complainant's Exhibit Brevoort Illustrative Drawing Y, Sept 26, 1888."

(Here follows diagram marked p. 81.)

31 Q. Mr. Renwick has testified that the ports in the mechanism described in the patent to Ortlieb of record are controlled. Please state whether you have ever read this patent; whether you have caused an illustrative model of said structure to be made, and whether you agree with Mr. Renwick in the opinion referred to.

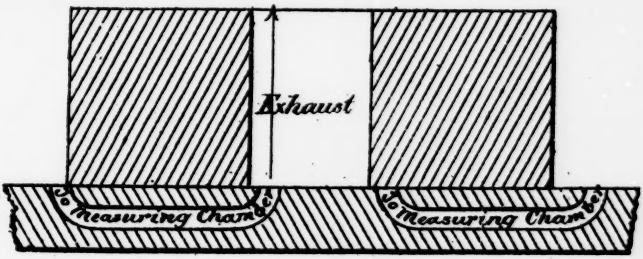
A. I have read the patent and I have caused an illustrative model in wood to be made, which I now produce.

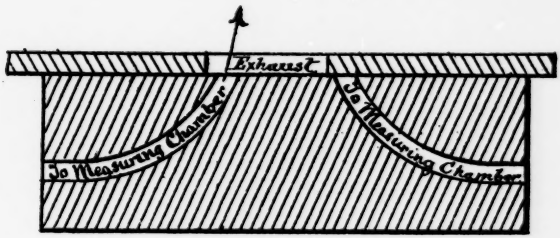
Model produced is offered in evidence and marked "Complainant's Exhibit Brevoort Model X, Sept. 26, 1888."

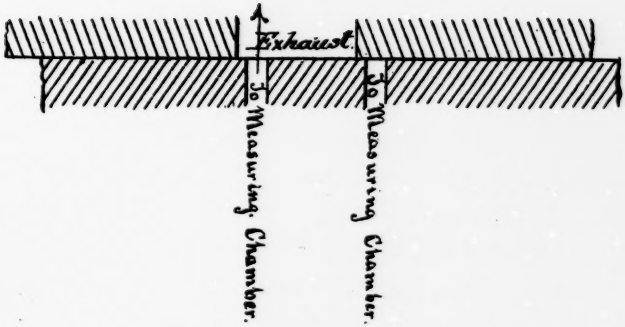
It will be seen by operating this model that the ports are always open. The ports that let in and exhaust the steam from the boiler are made up of three holes each, leading into one passage, while the ports of the low-pressure chamber are made not of holes but of a single slot, and the three holes above referred to might as well be cut into one. The piston sweeps over the ports in the operation of the engine, but the piston never closes the ports, and consequently I disagree with Mr. Renwick, and I do not think that the Ortlieb patent shows a device having ports which are controlled by anything.

32 Q. Mr. Renwick has testified that the 6th claim of the patent in suit is, in his opinion, limited to a structure in which the central opening is in the head plate and the plurality of smaller openings are in the piston. Are you of the opinion that this claim
83 is so limited?

Exhibit Y.







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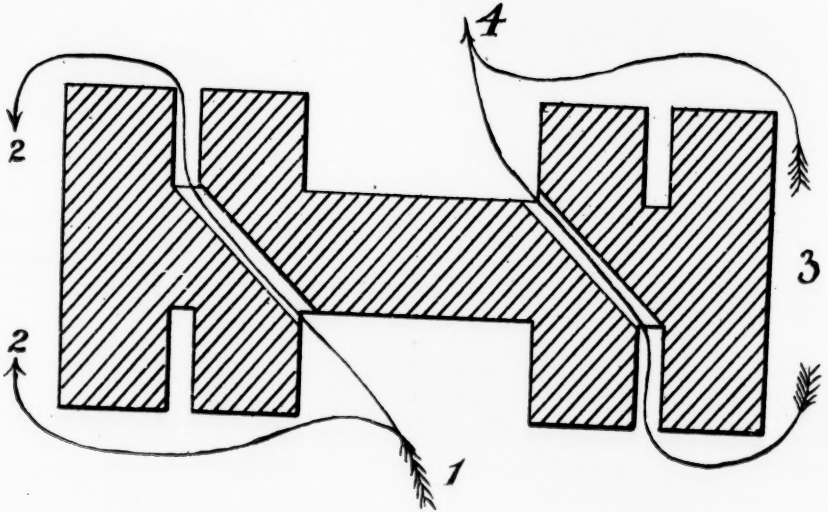
Bd Water Comrs.

Exhibit AB



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A. I am not. The two forms are substantially the same thing, as I have before said, turned about and no such limitation appears in the claim.

33 Q. Referring to the structure shown in figure 7 of the patent in suit, what modification in the valve shown in that figure would be required to make the said valve adapted to a piston of the non-rotating type, such as shown in defendant's meter?

A. Merely to make the number of ports in the valve equal to the number of the meter chambers.

34 Q. I place in your hand a meter manufactured by the company complainant and known to the trade as the "Crown" meter. Does this meter, in your opinion, embody the features covered by the 3d, 4th, 5th, and 6th claims of the patent in suit?

Objected to as new matter and not properly in rebuttal.

A. It does.

35 Q. Please explain briefly the operation of the ports in this meter.

Same objection.

A. I will do so. I now produce a drawing which illustrates the piston of the meter.

Said drawing produced and offered in evidence and marked "Complainant's Exhibit Brevoort Drawing A B, Sept. 26, 1888."

(Here follows diagram marked p. 82.)

Same objection as to question.

The water enters at 1 and follows the branching arrows to the point 2 2, which are in the meter chamber being filled. The water that is being exhausted leaves the meter chamber 3, follows the branching arrows, and is delivered at the point 4. The
84 arrows, where they pass over and under the piston, conduct through passages formed in the case of the meter.

Said meter offered in evidence and marked "Complainant's Exhibit Crown Meter C D, Sept. 26, 1888."

Same objection to exhibit as to question.

36 Q. Please compare the construction of the Crown meter, marked Exhibit C D, with the defendant's meter as to the operation of the exhaust ports.

Same objection, and also as incompetent and irrelevant and immaterial.

A. I have made the comparison called for in the question and I find that the two meters are substantially the same. I produce a drawing in which figure 10 shows the piston with its exhaust port 11 and the upper plate of the meter at 12 and the exhaust ports through the upper plate at 13 and 14. The exhaust port 13 contains an arrow showing the direction of the water as it leaves the meter chamber 15, passes through the port 13 into the port 11, and so out. This drawing represents the upper half of both the Crown

and defendant's meter. The same drawing represents the same part of the two meters.

Said drawing offered in evidence and marked "Complainant's Exhibit Brevoort Drawing B C, Sept. 26, 1888."

Same objection as to question.

(Here follows diagram marked p. 85)

37 Q. Referring to the engines described in the patent to Ortlieb and Chapman and Galloway and in "Kinematics," of record, please state whether those engines are, in your opinion, of any practical value or utility.

A. They are not. No rotary engine that I have ever seen or heard of has been of any practical use as an engine. It is one of
86 the dreams of mechanics to produce an efficient rotary engine, for its production would revolutionize the steam engineering of the present day. I have myself worked at the matter considerably and, it is needless to state, without success.

38 Q. Do you understand that the third claim of the patent in suit is broadly for a rotary piston having internal water passages?

A. No; I do not so understand the third claim.

39 Q. You have testified that the pistons of the meters of the patent in suit and the piston of the defendant's meter each and all have similar motions of translation, as you have explained the term. Does the piston of the Chapman engine have any motion of translation?

A. No; it merely has a motion of rotation around its own axis.

40 Q. Can, in your opinion, a structure having a piston with no motion of translation be the substantial equivalent of or belong to the same class as structures having pistons with such motions of translation as those in the meters of the patent and defendant's meter?

A. No; the pistons of the two classes are radically different and are properly separable into different classes having different capacities and functions.

41 Q. What motions of the pistons of the meters of the patent and of defendant's meter enable these pistons to themselves control the ports of the structures and enable them to act as their own valves?

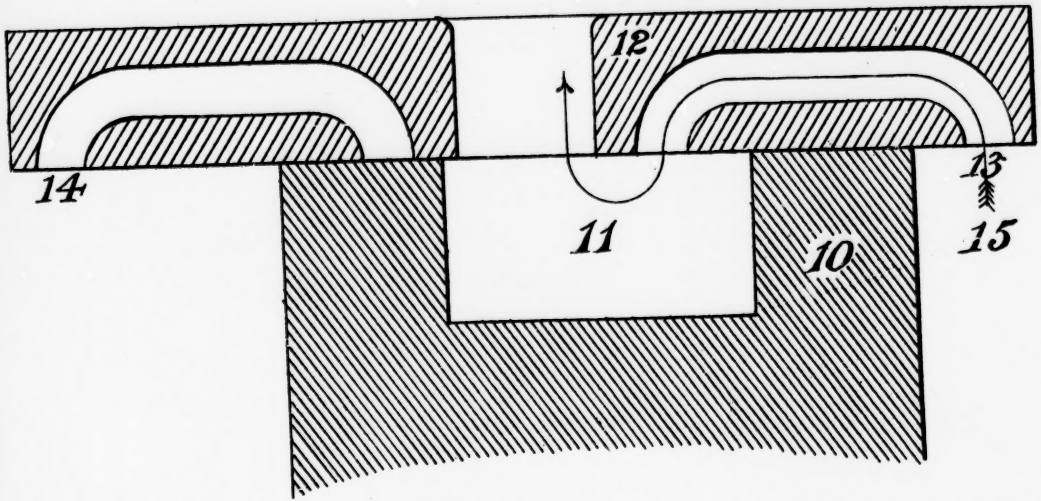
A. The motion of translation in both cases enables the piston to act as valves so that they can control the ports.

42 Q. Do you agree with Mr. Renwick that if this third claim be construed broad enough to cover defendant's structure it would also cover the structure described in the Chapman patent?

A. I do not agree with Mr. Renwick. The meter of the
87 defendants has a piston which controls ports by reason of its movement of translation, as in the patent in suit, while Chapman has no such construction.

43 Q. Do the internal water passages in the pistons of the meters of the patent and the defendant's meter co-operate with ports in the

Exhibit BC



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head plate to confer upon the piston the function of acting as its own valve?

A. Yes.

44 Q. Does the internal water passage of the piston in the Chapman structure co-operate with any ports to confer upon the piston the function of acting as its own valve?

A. The piston in the Chapman structure does not co-operate with any ports and the piston does not act as its own valve.

45 Q. Do you regard the water passages in the piston of defendant's meter as the substantial equivalent of the water passage in the piston of the Chapman structure?

A. No; I do not.

46 Q. What would be the effect upon the operation of the defendant's meter if the holes through the central web of the piston of the defendant's meter were stopped?

A. It would operate as before, but would not deliver as much water unless an extra exhaust pipe were added.

47 Q. What would be the effect upon the operation of the Chapman engine if the internal passage through the piston were stopped or divided by a closed partition?

A. It would stop it entirely and render it wholly useless.

48 Q. Referring to the engine described in the Ortlieb patent, has the piston in that engine any motion of translation?

A. No; merely a motion of rotation on its own axis.

Direct examination closed.

88 NEW YORK, *September* 27, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Mr. BREVOORT proceeded.

Cross-examination by Mr. FISH:

49 X Q. Have you seen any reason to change any of the views expressed by you in your deposition in support of the *prima facie* case because of the further consideration you have given to the matters here in controversy since that deposition was closed?

A. I don't recall any change of view that I have taken. I have a little more accurately defined what I understood to be the complainant's view of the mechanics of the matter and have gone into some of the questions that I touched upon in the *prima facie* at a little greater length; but as I carry the *prima facie* in my mind and without spending time to re-read it, I do not recall any change of view.

50 X Q. You have testified that by means of the diagrammatic model K you have illustrated in a simple form the displacing action of both the Nash and the defendant's meter. How far, if at all, does that model, when manipulated as described by you in your direct examination, illustrate the displacing action of either meter?

A. The model referred to in the question illustrates the action of the pistons in both meters; in the one case illustrating the com-

pound motion (to wit, the revolution of the piston, and also its motion of translation) and in the other case illustrating the defendant's form of meter, in which there is only a motion of translation. Now, strictly speaking, this model does not have any displacing action whatever, but does illustrate the motions of the pistons of the two meters while they are displacing the fluids in the chambers.

89 As I have before said in the direct examination, I purposely left off in this model the meter chambers or projections and made a piston without these projections and a case without projections for the purpose of illustrating simply the motions of the pistons when displacing the fluid, this piston being capable of representing the motions of the pistons of both of the meters without complicating the matter by the introduction of the meter chambers.

51 X Q. What portion of the piston of defendant's meter effects the displacement of the water for measuring purposes?

A. All portions. The projections of the piston and case and the wall uniting the several projections are directly instrumental, while the rest of the piston, I may say, for want of a better term, is indirectly instrumental.

52 X Q. At any given moment in the operation of defendant's meter what portion of the piston is directly effecting displacement for measuring purposes, and where does the displacement take place?

A. The projections that are in those chambers that are receiving water and the wall of the piston and case *from* the diminishing cavity on one side of the projections of the piston in each cavity, and in the same cavity on the other side of the projections of the piston the expanding cavity is formed. The cavity also through which the water is being exhausted from the diminishing cavity, to wit, the passages in the head plates and in the interior of the piston, are, in the operation of exhausting, a part of each of the chambers being exhausted, though they are not a part of that portion of the cavity or chamber which is contracting.

53 X Q. You have already testified, have you not, that in the forms of meter shown in the Nash reissue there is no such division of the cavities in the case by the projections on the piston into receiving and discharging chambers, but that the displacement is effected by a different relation between the moving piston having projections on it and the interior of the case? Is that the fact?

90 A. I do not think it is exactly the fact as stated in the direct, though it depends upon the construction of the language of the question in a large measure.

54 X Q. What is the nature and character of the division in the meters of the Nash patent into receiving and discharging chambers by which the displacement for measuring purposes is effected?

A. A projection from the piston enters a cavity, the cavity discharging while the piston enters it, and then on one side of the projection of the piston water begins to enter and on the other side of the projection of the piston the exhaust operation is closing while

the water is entering in the other side. In figure 11 one of the projections from the piston, for example, enters a cavity and displaces the water, and then the same projection on its journey to the next cavity, which it is to displace, serves as the dividing diaphragm between the cavity previously emptied and the cavity to be emptied, the projection from the piston being open on the one side to the inlet and on the other side to the outlet.

55 X Q. In the defendant's meters as the displacement is taking place in any chamber the orifice of that chamber is closed, is it not, by the body of the piston, so that neither the water received into nor the water discharged from that chamber can pass into any other chamber on the periphery of the case until the operation of displacement is completed in that chamber?

A. Meaning by the orifice of that chamber the opening other than the ports, I think the statement is substantially correct, but it seems to me that water must enter the receiving side of the chamber after that chamber has become open to the adjacent chamber.

56 X Q. Is there any meter shown or described in the Nash reissue in which the conditions indicated in the last question and answer and as characterizing the defendant's meter exists?

91 A. Not exactly, as I understand the question, though during the operation of the meters of the patent in some cases each chamber is a receiving and discharging chambers divided by the projections of the piston. In other cases, to wit, figures 11, the chambers are at times wholly receiving or wholly discharging chambers without communication with other chambers during the operation.

57 X Q. In which meters of the patent do you find each chamber a "receiving and discharging chamber divided by the projections of the piston"?

A. Figures 3 and 12.

58 X Q. In those forms of meter is the orifice of the chamber that is toward the piston closed by the body of the piston while the chamber is both receiving and discharging?

A. No.

59 X Q. Is it essential to the operation of the meters of the Nash patent that the projections of the piston should divide any of the chambers into receiving and discharging spaces or that those projections should come into contact with the deepest portions of the chambers in the case so as to divide them at all, or is any division of the chambers by the projections on the piston characteristic of the Nash meters?

A. I do not think it essential.

60 X Q. Such divisions of the chambers by the projections on the piston is an essential characteristic of the defendant's meters, is it not?

A. It is present in the defendant's meters. I do not know that it is essential except in the particular form in which their meters appear. I call attention to Exhibit M in answering this question.

61 X Q. Is not such division characteristic of Exhibit M?

A. Yes; it is in Exhibit M, which has a piston that rotates on its

own centre and which has a motion of translation around
92 the case as have the pistons of complainant's meters. As I understand the matter, it is a question of shape and portage.

62 X Q. In your answer to interrogatory 3 you have spoken of the engines of the Galloway 1846 patent and of "Kinematics" as "know equivalents." In what sense do you use the words "known equivalents"?

A. I think I use it in the ordinary sense. I mean to imply that to a mechanic having knowledge of the Galloway patent, after he had read the Nash patent, for example, would be informed how to apply those inventions that Nash made to a Nash meter based on the action of the Galloway steam-engine of 1846. As though this was not a sufficient state of the art, the book "Kinematics" supplies further light and shows that the motion shown by Nash in his patent and that used by the defendants in their meter were both, broadly speaking, known to mechanics.

All after "as though" objected to as irresponsive and volunteer.

63 X Q. You have testified that Exhibit Piston N is constructed with "the Nash portage as shown in the patent;" do you mean to say that the relative arrangement and position of the ports in that exhibit are in all respects the same as shown and described in the Nash patent?

A. They seem to be the same and are the same with the exception that the ports seem to be smaller in proportion.

64 X Q. Which of the drawings of the Nash reissue show the portage in piston Exhibit N?

A. Figures 1, 2, 3, 4, 5.

65 X Q. And the ports, both inlet, and outlet are six in number in the piston shown in those drawings and in Exhibit N, are they not?

A. Yes.

66 X Q. In the drawings the ports at the top and bottom of the piston are arranged in circles about the centre of the piston,
93 which circles are of substantially the same diameter, are they not?

A. I should think so.

67 X Q. What is the relative diameter of those circles in piston Exhibit N, referring to the holes where they leave the depressions that surround or are adjacent to those holes?

A. On the top about an inch and three-eight-s and on the bottom about an inch.

68 X Q. What is the relative diameter of the outside of the circle of ports, both in the top and bottom?

A. On the top about an inch and five-eight-s and on the bottom an inch and a half and a thirty-second.

69 X Q. Now, what are the diameters of the inside of the circle of ports on the top and bottom of piston Exhibit N, measuring from the inside edge of the countersinks?

A. On the top of the piston three-quarters of an inch and on the bottom of the piston about three-eight-s of an inch.

70 X Q. Why were the ports placed on the periphery of a smaller

circle on the bottom of piston Exhibit N than the circle on the top of that exhibit?

A. So as to accommodate the portage to a meter having the projections on the piston and the projections on the case even in number. Every different shape of points and different number of points requires that the portage should be made to suit the particular form selected.

71 X Q. Please explain more fully what you mean by the first part of your last answer, and state why the diameter of the circle of ports on the lower side of piston Exhibit N has to be less than the diameter of the circle of ports on the upper side of that exhibit in order to "accommodate the portage" to a meter having the projections on the piston and the projections on the case even innumber.

A. I don't know just why it was done. I did not personally lay the ports out, and though I noticed the difference I never
94 considered it a material one.

72 X Q. In your opinion, would the piston Exhibit N, when placed in the case of defendant's meter Exhibit D, having the head piece N, this being the combination specified by you in your direct examination and which you say you saw tested, operate as well as a meter if the circle of inlet ports was as large as the circle of outlet ports?

A. I don't suppose it would with the present head.

73 X Q. Would it operate at all as a meter?

A. I don't know till I try it.

74 X Q. Can't you tell by an examination of the meter, from your general knowledge of the subject and the test you have already made of water meters?

A. No, I can't; the crooked ports in the inside of the piston get me so mixed up on a hasty examination that I won't testify until I have made an experiment.

75 X Q. You are not then certain but that the arrangement of ports on the bottom of Exhibit N on the periphery of a smaller circle than the circle of ports on the top of Exhibit N, may be a violent departure from anything shown or described in the Nash reissue, and may be essential to the operation of the combination piston and heads N and case of Exhibit D which we are discussing?

A. Very possibly they are essential. Every meter has to be ported to suit its shape, and the shape of its points and this meter has been so ported. If there is one thing that the patent is specific about it is that the particular forms of portage are to depend on the particular form of case.

76 X Q. Where do you find such a statement in the patent?

A. I quote as follows from the 3d page, line 26:

"I do not wish to confine myself to either of the specific arrangements of the valves shown or to any specific construction of
95 such valves in relation to the piston, so long as the valves and piston co-operate to produce the results stated."

Further on, on the same page, at line 108, I find as follows:

"An important feature of my invention embraces the combination with a piston, adapted to operate substantially as described, of a

valve controlled thereby irrespective of its specific construction and arrangements."

77 X Q. Can you not suggest any specific reason, based upon your knowledge of the subject-matter of this case, why the circle of ports on the inlet or lower side of piston N is smaller than the circle of ports on the outlet or upper side?

A. I can.

78 X Q. Please do so.

A. The ports on the lower side are contracted so as to bring more into action at once.

79 X Q. Why are more brought into action at once?

A. Because there are more meter chambers ready to receive the inflowing water.

80 X Q. All those meter chambers are not discharging, are they?

A. Three are discharging at a time.

81 X Q. How many inlet ports are open at a time?

A. One more than the discharge..

82 X Q. That fourth chamber, to which the fourth port leads and which is not discharging, is full of water, is it not, and would be if the fourth inlet port was closed?

A. Yes.

83 X Q. Why, then, should the fourth inlet port remain open?

A. Simply to keep pressure in the meter.

84 X Q. For what purpose?

A. To keep the piston up to its work, which is necessary
96 when the Galloway form of points is adopted. With the "Kinematics" form this is not necessary. Any mechanic acquainted with the state of the art would understand this matter when he came to work out the ports.

85 X Q. In the defendant's meter where is what Nash calls in his specification "the line of pressure," represented by the line *z* in figure 12?

A. It is approximately at right angles to the movement of the piston and crosses the several chambers that are in action.

86 X Q. In the meters of the Nash reissue "the line of pressure" is at right angles to the line of motion, is it not?

A. In figures 3 and 12 it may said to be during certain positions of the piston, and in figure 11 the line of pressure and the line of motion may be said to be parallel. In figure 9 the line of pressure may be said to be at right angles to the line of motion, depending upon the position of the piston. In figure 10 the line of motion and line of pressure are parallel or coincident, and in figures 9 and 12 they vary with the position of the piston.

87 X Q. In your last answer in what sense have you used the phrase "line of pressure"?

A. The patent describes the line of pressure as a line connecting the points of division *x x* which separate the inlet from the outlet spaces of the cylinder. Now, using it in that sense, the figures do not show this line or division across the diametrical center of the meters in all the figures, but show it almost parallel in some and at different angles in others. In the defendant's meter the projections

from the piston divide each of the cavities into outlet and receiving spaces, which division forms the line of pressure, and the line of motion is at right angles to this line.

88 X Q. In the combination which you have made of pis-
97 ton N, case of meter D, and heads N, is it necessary or desirable that any of the inlet ports in the bottom of the piston should ever be covered up, or, in other words, is it of any consequence whatever that one port after the other should be covered up by the bottom plate, as is the case in that combination?

A. I have never tried it, but it seems to me, without thinking about the matter, that the piston could be controlled by the exhaust ports and not the inlet ports, though I can't say without working it out.

89 X Q. Can the meters of the Nash reissue be controlled by the outlet ports without controlling the inlet ports?

A. As in the previous case, I should have to try the experiment.

90 X Q. Can't you tell from an examination of the patent specifications and drawings?

A. No; what modifications can be made in the ports are numerous. I can say that the specification does not describe or show a form of meter in which the entry ports are always open and the meter is controlled by its exhaust ports.

91 X Q. Does it show or describe a form of meter which would be operative if the inlet ports were in fact uncontrolled instead of being controlled as shown and described?

A. I don't know until I make the experiment with the meter shown and the proposed form of portage.

92 X Q. I do not suggest any change in the form of portage except to eliminate the control of the inlet ports, and my question is, If the control of the inlet ports were so eliminated from the structures of the Nash reissue would those structures be operative, the outlet ports only being controlled? Will you not state what the facts would be on this point?

A. I should think they would not be operative with the portages as shown and all control of the entrance ports removed, but
98 with a different form of portage this might be accomplished, and, if it is desired, I will see what can be done in that direction.

93 X Q. It has appeared in evidence that the Nash meters can be run in either direction—that is, that the direction of the water and the motion of the piston may be reversed. Is that true of the combination of piston N, case of meter D, and head plate N which you have produced?

A. I should not think so, but I have never tried it.

94 X Q. Is it not quite clear that it will not run backwards?

A. I should not think that it could run backwards.

95 X Q. What are the differences between the combination meter referred to in the last question and the Nash meters which make it possible to reverse the motions of the Nash meters but impossible, in your opinion, to run the combination meter in both directions?

A. The difference in the portage and the fact that in the Gal-

loway type the piston must be held to its work by the water pressure.

96 X Q. What is the difference in the portage to which you refer?

A. If the meter was reversed the portage would not be adapted to keep the pressure in the neutral chambers and hold the piston up to its work.

97 X Q. You have referred several times to differences in portage characterizing the two types of meter movements, the Galloway 1846 patent, to which the defendant's meter belongs, and the "Kinematics" type, to which the Nash meters belong. Will you please recapitulate those differences?

A. Those differences which are necessitated by a rotating or a non-rotating piston—that is, a piston rotating on its own centre. A rotating piston, as in figure 12, may have three connected chambers open at one time to the incoming water, while in the non-
99 rotating meter adjacent and not connected chambers are opened to the inflow. In the non-rotating meter the water pressure must be on the neutral chambers.

Adjourned till Friday, the 28th inst., at 11 a. m.

NEW YORK, *Sept. 28th*, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. BREVOORT was continued as follows:

Witness continues:

However, a rotating piston may not necessarily have three connected chambers open at one time to the incoming water, and to prove this I refer to the case M with the piston D in it, which has both a motion of translation and a motion of rotation, and in which there are not three connected chambers open to the incoming water. I also refer to the Nash patent in evidence, No. 336,143, which shows a non-rotating piston in which connected chambers are open at the same time to the incoming water. Now, these differences do not distinguish any type, and I fail to see, when the matter is considered, how the types referred to in the question can be distinguished, for that which is true of one form can also be true of the other form.

98 X Q. Is not the portion of your last answer made since the adjournment inconsistent with the portion of the answer made before the adjournment?

A. Only to the extent that in the first part of the answer I pointed out certain apparent dissimilarities which seem to have been during the discussion regarded as material, and that in the second part of the answer I show that these dissimilarities are not true distinctions.

100 99 X Q. Please answer cross-interrogatory 96 in the light of your present view of the subject.

A. I suppose there is no use of doing so again at length. I fail to see that there is any real distinction between the devices referred to. There are certain differences, but these do not seem to be mate-

rial, as the features of the rotating form of piston and the non-rotating form may be present in either form of meter. The only distinction that exists and which is evident is the distinction that one piston rotates and the other does not, and this is not a substantial difference or a material difference.

100 X Q. You speak in your last answer of "either form of meter." Are the forms you refer to those that you have heretofore designated as the form of the Galloway 1846 patent and the "Kinematics" form?

A. I had in mind the form of defendant's and complainant's meters, and the Galloway 1846 patent and "Kinematics" show engines of these forms respectively, but, as the exhibits show, the forms are substantially the same.

101 X Q. In the combination made of case M and the piston of Exhibit D does the piston have a "side-rocking" movement within the meaning of that phrase as used in the Nash reissue?

A. I should say it had rather the eccentric than the side-rocking movement, if a distinction is to be drawn between these movements.

102 X Q. Why?

A. Because if any distinction is to be drawn between eccentric and side-rocking it is the distinction that I drew before as to the small arcs made by the centres of the piston, but I do not know that this distinction need necessarily be drawn.

103 X Q. Is any result produced by the special form of porting in the Nash meter made for commercial use, a specimen of which
101 has been introduced in evidence, marked C D, that is different from the result produced by the form of porting shown in the Nash reissue?

A. I don't know of any, unless the porting of the meter C D gives a better balance to the piston.

104 X Q. Would the porting of the meter C D give a better balance to the piston?

A. I should think it would.

105 X Q. Why?

A. Because it receives and discharges from both sides.

106 X Q. How and why does that effect the balance of the piston?

A. Because it receives and exhausts from both sides?

107 X Q. That explanation may be perfectly clear to you, but possibly not to me or the court. I should like to have your reasons for your statement at greater length.

A. All I can say is that by admitting water on both ends of the piston and discharging it from both ends a better balance of the piston within the case will result. The arrangement of the ports makes the piston like a balanced slide-valve, which is a device commonly used on locomotives and steamships.

108 X Q. You have spoken in your last answer only of the fact that water is admitted on both ends. Does the fact that the water is discharged from both ends of Exhibit C D affect the balance?

A. I should think it tended to preserve it.

109 X Q. Is this balancing of the piston of any importance in a water meter; and, if so, how important is it?

A. I don't know how important it is; I should imagine that it was advantageous.

110 X Q. In a piston having the porting of the Nash reissue what would be the practical consequences arising from the fact that the piston is not balanced when the same is used in a water meter?

102 A. I suppose the piston would rub a little harder on one end or the other, but as the water is taken in below and the piston is heavier than the water the tending in the figures where ports are shown would be to counteract the weight of the piston by the pressure of the inflowing water. How much this would be I cannot state.

111 X Q. Upon what does the amount of the upward pressure in such case depend?

A. On whatever portion of the bottom of the piston was exposed to the inflowing current. How large this area would be or precisely on what surfaces it would act are questions that I must take time to consider.

112 X Q. Does not the area exposed to the relief of the water have anything to do with it?

A. Yes; but for equal areas the relief pressure is the least.

113 X Q. Does not the area of the relief in fact effect the measure of the upward pressure with an unbalanced piston?

A. The area of the portion of the piston exposed to the inlet, the area of the portion exposed to the outlet, and the relative pressure of the outflowing and inflowing waters are all factors in the calculation.

114 X Q. If the area of the relief were one inch and the difference in pressure between the inlet and the discharge were ten pounds to the square inch, what would be the pressing weight of the piston against the top plate, assuming that the area of the inlet is the same as of the outlet?

A. I won't attempt to make calculations of this nature suddenly and without having time to thoroughly consider the matter.

115 X Q. Is not the problem suggested in the last question a simple one that you can easily answer from your general knowledge?

A. I might, but I am not going to make calculations on the witness stand; I will gladly make the calculation and give the result at a later date.

116 X Q. Please make the calculations before the next hear-

103 ing after to-day.

A. I will.

117 X Q. Look at the patent No. 211,769 to Lewis Nash, the patentee of the patent here in suit, and state whether or not the porting shown and described in said patent is the porting of the Nash commercial meter, Exhibit C D?

A. It is, I believe, though I have only examined the drawings.

The inventor, Mr. Nash, who is present, states that it is the same porting.

Counsel for defendant introduces said Nash patent in evidence, and the same is marked "Defendant's Exhibit Nash Patent Porting Nash Commercial Meters, Sept. 28, 1888."

118 X Q. Please compare the porting of the engine shown in the Galloway 1846 patent with the porting of defendant's meter, Exhibit D, and state how the same resembles or differs from each other.

A. The lines of pressure upon the parts seem to me the same as in defendant's meter. The porting, however, is entirely outside of the piston and the cylinder. The steam enters through holes in the cylinder-head plate, which is attached to the piston when these holes are in the proper position to the valve face. The exhaust passes out through slots in the same cylinder-head plate into holes in the valve face and is discharged. The lines of pressure I speak about in the first part of my answer are the horizontal lines and not the vertical strains or lines of pressure, which are different. In the Galloway engine the cylinder-head plate is pressed downward with a force equivalent to the pressure on the head plate of the steam which is not balanced under the head plate and also by the weight of the parts.

119 X Q. The unbalanced downward pressure on the head
104 plate of the steam, to which you refer, is considerable in the Galloway engine, is it not?

A. I should think it would be.

120 X Q. Is the piston of the defendant's meter balanced or unbalanced?

A. It is practically balanced. It is in the same condition as the meter of the patent. If the incoming water just balances the weight of the piston, then the piston would be perfectly balanced.

121 X Q. Would not the piston of the Galloway engine move around exactly the same if the crank with its spring were altogether dispensed with?

A. Galloway did not think so, apparently, and I do not like to contradict the inventor. If the piston were started properly, to begin with, I suppose it would move around without the crank, but it would not start again unless it was stopped properly. I suppose, according to Mr. Renwick's statement, that it would "chatter" without a spring.

122 X Q. Would the piston of defendant's meter be any more likely to start if it were not stopped properly?

A. I think it would, on account of the lightness of the parts and the practical consideration that water is passed through the meter instead of steam. Theoretically, if the piston of the Galloway engine or the piston of defendant's meter were stopped in the middle, the engines would blow through and the pistons would stand still; but in Galloway the steam or the fluid used does not pass into any part of the piston, and consequently the fluid would not in Galloway have the same action on the piston as it would

have on the meter, where it is impossible to conceive of the parts standing or being in themselves so even that the piston would remain unmoved.

123 X Q. In any form of meter shown and described in the Nash reissue can the centre of the piston be brought into such position that it will be coincident with the centre of the case?

105 A. If the question means bringing the centre of the piston over the centre of the case, this cannot be done with either of the figures shown in the Nash reissue, but with pistons which rotate on their own axis and have a different number of points from the points in the case, a meter can be made that will admit of such a placing of the piston.

The witness now answers the question as to the calculation in cross-interrogatory 113, the calculation having been made during the intervals of the examination and before recess.

The upward pressure would be ten pounds minus the weight of the piston and parts carried by it, which lent their gravity to it; and this answer is given with the assumption that all parts fit tight and it disregards all questions of friction of water in passages.

124 X Q. Then if the piston and parts carried by it, which lent their gravity to it, weighed ten pounds, would the piston be balanced?

A. Without other considerations, yes.

125 X Q. What other considerations have you in mind?

A. I have none, but I put in the statement lest counsel might.

126 X Q. Then, in so far as there is any advantage in a balanced piston, it would be an advantage to have the weight of the piston, under the conditions just referred to, ten pounds, would it not?

A. Yes; but the conditions are phenomenal.

Adjourned for lunch till 2.30 p. m.

Resumed after lunch.

127 X Q. Is it not true that a spring so slight as not to be

106 able to start the Galloway piston when at rest might have some effect upon its motion when the piston is itself moving?

A. I think it is possible, though I think one of the offices of the spring is to ensure the pressure of the piston against the case when the engine was stopped, and the movement of the piston during stopping must be very slow, and there cannot be much difference in the force required to deflect from its path the piston in this condition and a state of rest.

128 X Q. Is not the lateral pressure of the steam or water in what have been called the neutral chambers of the Galloway engine and defendant's meter greater than could be effected by even a very strong spring?

A. I cannot state the amount of pressure, as this would require calculation and of rather an intricate kind, but there would be a pressure towards one side of the case in both devices. The pressure might be very heavy in Galloway, while it might be very light in the case of the meter. The Galloway engine is a steam-engine with

a free exhaust, and in the meter it is a water engine with very little difference in pressure between the initial water and the exhaust. In the meter the object is to have a piston that will move as easily as possible, and you do not want to use up or expend the head of the water, which is valuable, whereas in a steam-engine it is desirable to use as much of the head as possible, and two and three cylinder compound engines have been designed for this purpose.

129 X Q. This lateral pressure in the defendant's meter would be relatively light with a small stream of water, would it not?

A. I do not believe it would be any lighter to speak of. If it was any lighter it would be due to the contracted exhaust. It probably would be lighter to this extent.

130 X Q. Does not the defendant's meter, as shown in Exhibit D, have a device to assist this lateral pressure of the water,
107 "especially when the water pressure upon the piston is exceeding light," which is patented to Mr. Tilden in patent 357,159 and described from lines 57 to 76, page 2 thereof?

A. The spindle of the piston where it connects with the driving mechanism is supposed to be pushed outward by the shape of the driven arm. I have never experimented to see whether this would have any effect. It is described in the patent referred to. I do not believe it would have any substantial utility or any utility whatever.

131 X Q. I observe that the shapes of the projections on the pistons and cases O, P, Q, R, referred to in your answer to interrogatory 6, are not the same as the shapes of the corresponding portions of any of the pistons or cases shown in the Nash reissue, nor are they of the shape of the corresponding portions of the defendant's meter. Do you know why the projections in the exhibits referred to were given the particular shapes shown in those exhibits?

A. The object of giving the shape to the points was to make the cylinders and various pistons fit. Other shapes of points of piston and points of case could have been adopted. Cases D and M are another shape of points where the pistons can be made interchangeable, and of these shapes is the defendant's own meter.

132 X Q. Does the piston Q in case O have the "side-rocking" movement of the Nash reissue?

A. I should more properly define it eccentric.

133 X Q. In your answer to interrogatory 12 you say that if you place in Exhibit P the piston V with the pulley V in it and rotate the shaft of the eccentric pulley "it will be seen that the piston would have the same motion that it would have if it were guided by the walls alone, thus showing that the movement of the piston is truly eccentric;" and you also state that when you take the piston V and place it in the case O, in connection with the eccentric pulley W, and rotate the shaft you get an eccentric motion of
108 the piston, and you conclude by saying, "I think a thing that is directly driven by the motion obtained from an eccentric pulley must be said to have eccentric motion." What is your definition of "eccentric motion" or "movement" as you have used the same in that answer?

A. I define it by an illustration. The strap of an eccentric pulley has eccentric motion. A body moving around within a cylinder and smaller than the cylinder, as, for example, the piston of Exhibit K, shows an eccentric movement. I do not know any phrase that is universally expressive of eccentric motion.

134 X Q. Either of the combination models referred to in the last question and in your answer to interrogatory 12 might be driven by a crank as well as by an eccentric, the crank pin being at the present centre of your eccentric and the crank shaft being at the position of the present eccentric shaft, might they not?

A. A crank could be substituted for the eccentric.

135 X Q. Considering that the pistons in controversy have neither a crank nor an eccentric, and that their motions, in so far as they are embodied in the wooden models last referred to, are the same, is there any reason why the motions of those pistons should be described as eccentric motions, any more than as crank motions, and would you regard "crank motion" as a proper description of their movements?

A. In so far as both a crank and an eccentric have the capacity of moving connected devices in circles, either name might be expressive, but the term "eccentric," besides indicating the movement of the pistons in a circle, also indicates, as I understand the term, their relation to the case. I will illustrate: I take Exhibit K, and I hold its piston central in the centre of the cylinder, and I turn it around and around on its own axis. This motion might be given by a crank, and still there is nothing eccentric about the device. I now move the piston around the interior of the case, and
109 though that movement might also be given by a crank as well as an eccentric, it will be seen that the piston is eccentric to the case, and for these reasons I think the term "eccentric" is the most applicable.

136 X Q. Might not the same motion of the piston of Exhibit K, when central in its case, be effected as well by an eccentric as by a crank?

A. No.

137 X Q. How would you arrange the crank to effect that movement?

A. I would put a shaft through the device and a crank pin in the disc that forms the piston.

138 X Q. I show you a drawing in which I think an eccentric would effect the same movement of the circular piston K; do you not think it would effect that movement?

A. I am merely shown a drawing of an exhibit crank pin.

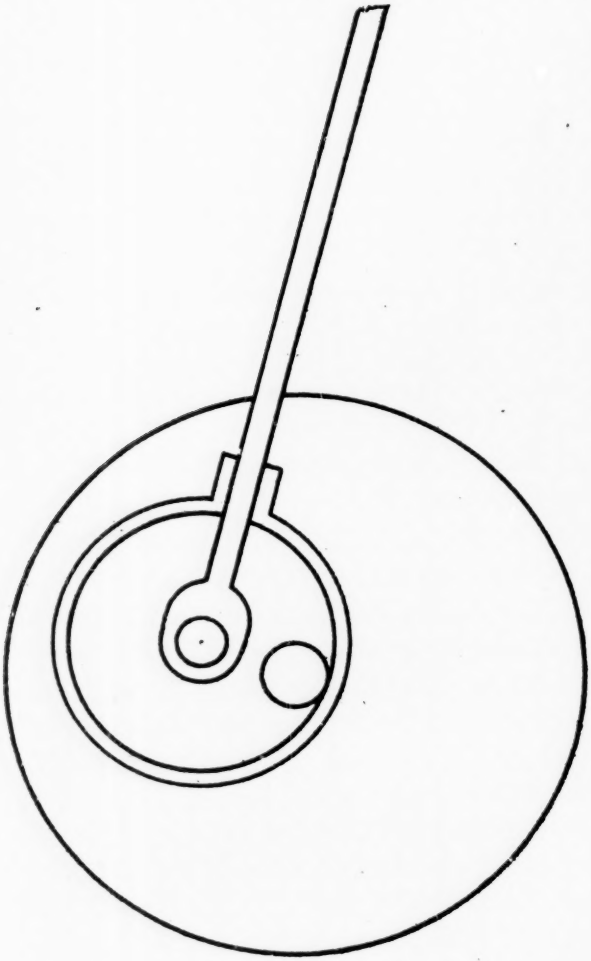
139 X Q. Are not the pulleys V and W enlarged crank pins in the same sense?

A. No.

140 X Q. What is your distinction?

A. V and W drive surrounding straps, whereas the device shown is driven by the strap. The lines marking the distinction between a crank and eccentric can be merged into each other by enlarging

Exhibit Eccentric Sketch



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} p. 110.

or reducing the parts, and although distinctions in name can be drawn, distinctions in substance disappear.

The sketch shown the witness is introduced in evidence and marked "Defendant's Exhibit Eccentric Sketch, Sept. 28, 1888."

(Here follows diagram marked p. 110.)

141 X Q. In both the combination models referred to in cross-interrogatory 132 and in your answer to interrogatory 12, one having the piston V and pulley V in Exhibit P, and the other having
111 the piston V and pulley W in case O, the shaft driving the eccentric pulley passes through the centre of the case. It is essential in order to effect the movement of the piston in either of those combination models, that the shaft carrying the eccentric should pass through the centre of the case.

A. As the models are constructed it is.

142 X Q. In the model made of pulley and piston V and case P might not the shaft be carried at least an eight- of an inch from the centre of the case without any other change of construction except moving the whole pulley one-eighths of an inch to one side of the piston P, changing the hole in the piston so that it would encircle the pulley in its new position?

A. As every point in the piston makes a circle, the piston could be moved as in the model in the book "Kinematics," where the shaft need not be in the centre.

143 X Q. The piston in the model "Kinematics" was not referred to in the question, and I now ask you to answer the last question without reference to that model.

A. Yes; that can be done by changing the construction of the eccentric, the shaft, the hole it goes through, and the hole in the piston as it now stands—that is, changing it in the manner indicated in the questions—and this can be done because all parts of the piston move in circles.

144 X Q. Could the piston of the other combination model, made up of the piston V, pulley W, and case O, have its motion given it if the same changes were made in the position of the pulley shaft and hole in the piston—that is, if they were moved away from the centre, as described in the preceding question?

A. I should think not.

Adjourned till Saturday, the 29th inst., at 11 a. m.

112 SATURDAY, *September* 29, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. BREEVORT continued, as follows:

144¼ X Q. Could the required motions be given to the pistons of figures 3, 9, and 12 of the Nash reissue by means of an eccentric pulley such as you have employed in the combination model referred to in the last question?

A. No, because the figures described by the centres of those pistons are not circles.

145 X Q. Could the required motions be given by such an eccentric to the piston of Exhibit- U and C D?

A. Not with an eccentric which closely fitted the strap which would be the piston, but I am not certain without experiment as to whether or not I could make an eccentric operate the meters referred to in this and the last questions.

146 X Q. How would you go to work to make such an eccentric, according to your present views?

A. I cannot say without laying out some diagrams and working the matter up more fully than I have here.

147 X Q. Can you not make a single diagram illustrating what you had in mind in your suggestion in the last part of answer to cross-question 145?

A. No, not now. I will think the matter over and see if I can do it later.

148 X Q. Would you go so far as to say that the motion of any moving body driven directly by the periphery of an eccentric pulley was an eccentric motion?

A. I think the question is rather broad, and I will await an example.

149 X Q. Broad as the question is, I would like to have you answer it in its present form. Please do so.

114 A. I dare say that such a desire exists, but, without getting it in some more tangible shape, I must respectfully decline to bind myself by a set of words in response to a question, the meaning of which may be very different in one person's mind from what it is in another's.

150 X Q. Then you are not now prepared to say that the motion of any moving body driven directly by the periphery of an eccentric pulley would be an eccentric motion?

A. I will say this: it would be a motion derived from an eccentric.

151 X Q. So much is clear, but your answer is not responsive. Will you make it so?

A. I don't think I can without a little more definiteness in the question.

152 X Q. You have just made a sketch and shown it to counsel for complainant. Will you produce that sketch in evidence?

A. Yes.

Sketch is introduced in evidence and marked "Defendant's Exhibit Brevoort Sketch No. 1, Sept. 29, 1888."

(Here follows diagram marked p. 113.)

153 X Q. Would you call the motion of the slide in the sketch produced an eccentric motion?

A. No; I should call it a rectilinear motion derived from a cam and a spring, the cam happening to have the shape of an eccentric pulley.

Exhibit Brevoort Sketch No. 1.

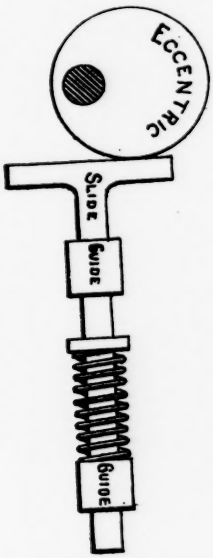

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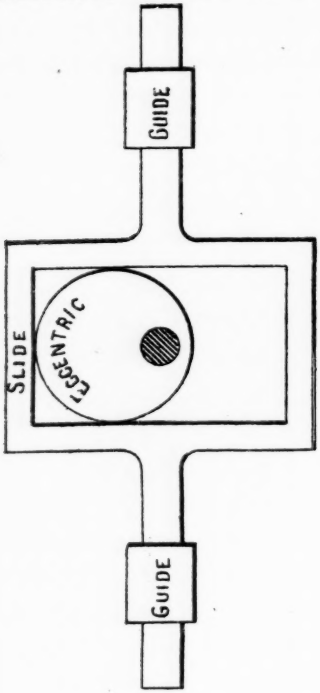
Exhibit Brevoort Sketch No. 2.



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154 X Q. I now show you another sketch, introduced in evidence and marked Defendant's Exhibit Brevoort Sketch No. 2——

(Here follows diagram marked p. 116.)

—which you did not make, and ask you if the eccentric pulley in that sketch would not cause a rectilinear motion of the slides through the guides.

A. I have examined the sketch made by Mr. Tilden. The statement in the question is true.

115 155 X Q. Would you call the motions of the slides in drawing No. 2 an eccentric motion?

A. I should call it a rectilinear motion derived from an eccentric pulley. I should not call the motion of the slide an eccentric motion.

156 X Q. The Read patent here in evidence speaks of the lightness of vulcanized or hard rubber as an advantage in the water-meter pistons referred to in that patent. Do you question the accuracy of that statement as applied to the pistons of that patent?

A. No.

157 X Q. In what sort of meter was the rubber piston of the Read patent intended to be used?

A. In what is called a screw-propeller meter.

158 X Q. Do you know how much play there is between the piston of the commercial Nash meters and the top and bottom or heads of the case?

A. I have never measured it. It is some very small fraction of an inch; probably much less than a hundredth and much more than a thousandth.

159 X Q. If the hard-rubber piston in either the plaintiff's or defendant's meters expanded appreciably would not they bind between the top and bottom plates?

A. If they expanded sufficiently to fill up the space between the head plates they would bind.

160 X Q. Does hard rubber, in fact, expand or change its shape when immersed in water?

A. Yes; under changes of temperature.

161 X Q. To any appreciable extent?

A. Yes; to an appreciable extent. I do not know this from having made experiments on the subject, but think it is a matter of common knowledge.

162 X Q. How about celluloid, if immersed in water?

A. Celluloid usually loses the volatile solvents first, and then the less volatile surface solvents, and generally contracts, and from an unequal loss of solvents changes shape.

117 163 X Q. Could not a hollow brass piston be used in the defendant's meter with satisfactory results?

A. I guess it could be used, but I don't think the results would be very satisfactory. I have never seen such a piston and can only give guess-work answers.

164 X Q. Why would not the results be satisfactory, in your opinion?

A. I should think the piston would be expensive. They would be apt to become dented, and I should think brass on brass would not wear, and there may be very many other difficulties with which I am not acquainted.

165 X Q. Is the piston of defendant's meter, Exhibit D, solid or hollow?

A. It is a hollow, hard-rubber piston.

166 X Q. What supports the weight of the piston of the meter of the Fitts patent?

A. Fixed upright spindles D and D^1, upon which the pistons turn.

167 X Q. Would not the tops of those spindles wear down in use?

A. Yes.

168 X Q. And where would the piston then bear?

A. On the bottom of the case, and the meter would be ruined.

169 X Q. If the pistons of the meter were very light, would it be ruined?

A. I should think so. The class of meters to which this belongs must, I understand, have pistons which can rotate without touching the case or coming in frictional contract at any point under the journals.

170 X Q. Which would wear down the spindle more quickly, a heavy piston or a light piston?

A. A heavy piston.

171 X Q. Which would have the greater friction with the case after the spindle was worn down, a heavy piston or a light piston?

118 A. Disregarding the material of the surfaces in contact, I should think a heavy piston.

172 X Q. Does the piston of the defendant's meter control the inlet ports; if so, how?

A. It does, by superimposing itself upon the inlet ports and closing them.

173 X Q. In Exhibit D does the lower face of the piston close any of the inlet ports?

A. It closes all that is open of each port.

174 X Q. Does it altogether close any of them?

A. I can see a little daylight through, but the space left is excessively small.

175 X Q. Would not the defendant's meter work just as well if the inlet holes were in the walls of the case and not in the plate of all?

A. I should think so, though I have never tried it.

176 X Q. Is it not really the vertical walls of the piston and cylinder that control the inlets?

A. Not as I understand it.

177 X Q. They would control the inlets, would they not, even if the holes in the bottom of the case were not closed at all, or if the inlet holes were in the walls of the case instead of being in the bottom?

A. The piston has got practically to shut up those holes during part of its movement.

178 X Q. You have testified that, in your opinion, the defendant's meter would work just as well if the inlet holes were in the walls of the case and not in the plate at all. In that case the vertical walls of the piston and cylinder would control the inlets, would they not?

A. They would have to shut them and open them.

179 X Q. And thereby control them, would they not?

A. Yes. The points might have to be a little differently shaped, I should imagine.

180 X Q. Do you know why the holes in the projections of Exhibit N, or some of those holes, were first drilled in a different place and then plugged up, as appears from an inspection of that exhibit?

119 A. I suppose it was to get the ports properly shaped to fit against the walls of the case in which it was intended to act.

181 X Q. Was it to get the ports in a proper shape or in a proper position?

A. Both, I guess.

182 X Q. What change of shape was made by changing the position of the orifice?

A. The plugs that were put in either reduced the size of old ports or plugged up old ports and allowed new ones to be bored. The effect was to carry the ports inward in the piston.

183 X Q. Would the inlet ports have been properly controlled if the orifice had been where the plugs now are?

A. I could not tell without trying it, but I think their present position is the proper one.

184 X Q. Who superintended the construction of Exhibit N?

A. I suppose Mr. Nash did.

185 X Q. Would not Exhibit N in case D be equally operative if all the holes in the bottom of N were consolidated into a cavity from the vertical walls of which led a hole into each chamber located where the present orifices from the inlets into the chambers are situated?

A. I don't know whether it is so ported that this could be done.

186 X Q. I should like to have you consider the question and answer, if possible.

A. Consideration won't help me. I must try it, but I will think it over and see if I can make up my mind.

187 X Q. You understand the porting of Exhibit N and the requirements necessary to make it operate, do you not, when placed in case D?

A. I do, but when the pistons with the crooked ports are involved I admit that time is necessary for consideration when a new relation of ports is enquired about.

120 188 X Q. In the arrangements suggested in cross-interrogatory 185 the inlet orifices into the chambers of Exhibit N are to remain where they are now, and the only question, as it seems to me, is whether the proper entrance of the water into the chambers

would be controlled in that arrangement if the inflowing water was not separated into distinct streams until after it has passed into the body of the piston, when it would be allowed to flow through the six holes intermittently in the vertical walls of the piston referred to in that cross-interrogatory. Can you not state whether in that construction the inflowing water would be properly controlled?

A. Of course, that which is enquired about in the last question can be done as I now understand it.

189 X Q. You have testified that the ports of the engine of the Ortlieb patent are not controlled. Is that the fact?

A. Yes.

190 X Q. If so, why does not the steam in that engine pass directly from the inlet to the outlet?

A. Because of the slides that intervene.

191 X Q. Do not they control the ports?

A. No; the ports are never closed.

192 X Q. Are they not controlled?

A. Not as I understand that term.

193 X Q. And the reason why you say the ports in the Ortlieb engine are not controlled is because the holes in the bottom of the model, Exhibit X, are never altogether shut. Is that it?

A. The three holes in the end of the case are merely one port with two bridges across, and this port, for it is really one port, is never closed and steam is flowing through it continuously, and therefore it is not controlled.

194 X Q. Do not the portions of the Ortlieb piston which prevent the steam from blowing through from the inlet to the outlet, and which you have called the radial slides, have motions of translation within your understanding of the meaning of the term?

121

A. Yes.

195 X Q. In your answer to interrogatory 14 you have stated that "in speaking of a motion of translation the centre of the mass is the point of the moving body that is considered." Will you explain what you mean by that?

A. The centre of the mass of the moving bodies. I don't think I can explain it more clearly than the definition which I took from a book and which describes the path of a body having a motion of translation as that described by the path or movement of the centre of the mass of the body.

196 X Q. What is the centre of mass of a body of irregular shape like, for instance, a chair or carriage?

A. I suppose it would be the central point of that mass in relation to its several irregular projections.

197 X Q. That centre might be very far from one side of the body and very near another side, might it not?

A. Yes; it might.

198 X Q. In speaking of the motion of translation of such a body you would speak only of the motion of this centre and not of the motions of the other portions, would you?

A. The movement of the centre of the mass, as I understand it, is mathematically the path of the motion of translation.

199 X Q. Practically would the movement of that centre be the same as of other portions of the mass in an irregular body?

A. They might describe the same or different curves or paths.

Adjourned for lunch.

122 Resumed after lunch.

200 X Q. The Ortlieb patent says that the ports are controlled by the radial slides. Do you question the accuracy of the statement?

A. I question the accuracy of the expression when applied to different mechanisms, the ports of which are controlled in the sense of being closed so that there is an intermittent flow through the ports.

201 X Q. You have testified that if the web in the central hole in defendant's piston be made solid the meter would act as before, except that there would be less water discharged. Is that the only difference in operation that would follow the closing up of the holes of the web?

A. The balance of the piston would be affected.

202 X Q. What is the function of that web?

A. It carries the spindle that works the register and permits of the passage of the exhaust water through it—makes the piston more solid—and the friction of the water through the holes may have some action on the balance of the piston, but I am not sure as to this last point.

203 X Q. Is the shape of the piston and case in Exhibit U like any of the pistons or cases shown in the Nash reissue?

A. Substantially, though not identically.

204 X Q. Which of them is it most like?

A. It is somewhat like figure 3 and figure 9, but not identical with either.

205 X Q. Do you know or can you tell how long Exhibit U has been in use and how much water it has registered?

A. No.

206 X Q. You say you have tested that meter in its present condition. What was the test you made?

A. I tested it on an eighth and a full stream only, and on
123 a full stream for one revolution of the dial it passed sixty-six pounds, and with the eighth stream it passed sixty-four pounds on one revolution.

207 X Q. What should have been the weight of the water metered during one revolution of the dial if the meter had registered accurately?

A. I don't know the number of pounds, but I am informed by Mr. Nash that it should have run sixty-two and one-thirty-seventh of a hundred pounds, that being the weight of a cubic foot of water, and the meter should have passed one cubic foot for one revolution of the first hand on the dial.

208 X Q. In what part of the meter did the leakage occur by which somewhat more water was passed than 62.37 pounds?

A. I don't know definitely. I suppose it leaked around over the

ends of the piston and around the case, but neither I nor any one else can tell definitely.

209 X Q. Would the piston of defendant's meter, in your opinion, be a "free" piston within the meaning of that term as used in the Nash reissue if its spindle were attached to the registering mechanism by means of a crank?

A. The answer to this somewhat depends upon the crank. I can imagine it might be a "free" piston and have a crank and might not be a "free" piston and have a crank.

210 X Q. What is the distinction that you have in mind?

A. If the piston is controlled by the crank I should say the piston was not free, but if the crank exercises no more control over the piston than does the present arm I should say the piston was "free."

211 X Q. Suppose the crank was constructed like the crank of the Galloway patent, but made of proper size to drive the registering mechanism in connection with the piston of defendant's meter, would you say that the piston was free?

124 A. I do not know what mechanism precisely or what modification of Galloway counsel has in his mind, and I reserve my definite answer till I have seen the proposed mechanism. If Galloway is followed I take it that the mechanism will show a controlled piston, but I will say definitely when I see the mechanism.

Adjourned till Tuesday, Oct. 2d, at 11 a. m.

NEW YORK, *Oct.* 2, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. BREVOORT was continued, as follows:

212 X Q. Is not the piston of the Galloway 1846 patent free to travel along the sides of the case, conforming its path to the sides of the case, and what difference in freedom between the motion of that piston and of the piston of the Nash reissue can you point out?

A. In the Galloway 1846 patent engine the piston is not free, because it has to carry with it the cylinder-head plate and move this plate over the valve surface, which is tantamount to imposing work upon the piston while it moves in its case, and thus the piston is not itself free, but is called upon to perform work and move a separate and distinct part other that the piston. The piston undoubtedly follows the walls of the case, and to ensure this action on the part of Galloway's a crank and spring are introduced to control the movements of the piston and force it against the walls of the case.

213 X Q. The Hartford English patent, No. 865 of 1852, a copy of which I now show you, shows a piston and case like Galloway's, does it not, and in the engine of that patent a piston moves

125 between two end plates as in defendant's meters, or, in other words, in that engine the upper plate is not carried by the piston, as in the Galloway 1846 patent. Is not that so?

A. The Hartford patent shows an engine with a piston like Galloway's moving within a rotating case. Both piston and case rotate. The piston does not carry a cylinder-head plate. Throwing out of consideration the question of which part moves, the piston and the case in Hartford has the same relative motion as has Galloway's and complainant's and defendant's meters.

The Hartford English patent is offered in evidence and marked "Def't's Exhibit Hartford English Patent, Oct. 2, 1888."

214 X Q. Would the side pressure in a meter like the defendant's, which keeps the piston up to the sides of the case, or up to its work, as you have expressed it, be necessary if the piston were not so free and uncontrolled in the sense in which you have used those words?

A. I can best answer by saying that Galloway thought it was necessary, and he had a piston which was neither free nor uncontrolled. I think it is necessary in a meter having a free and uncontrolled piston to have this side pressure. Even with a controlled piston I think it is advantageous.

215 X Q. Why?

A. Because it tends to ensure a fit in a piston like Galloway's.

216 X Q. When the defendant's piston of Exhibit D is in its case and in actual operation, what possible play is there towards and from the center of the case?

A. None, except the looseness of the fit of the piston in the case.

217 X Q. You have testified that you put the piston of Defendant's Exhibit D into case M with heads M and operated the
126 same. To what extent did you operate it and with what result, so far as metering water is concerned?

A. I put it on the stream and saw that it rotated properly. I did not attempt to measure its accuracy as a meter, because the case M was gotten up in a hurry and no strict attention to accurate fit of parts was attempted, as the exhibit was intended to show that a meter could be made in this way, while to make such meters would require special tools, as does any particular form of meter to ensure accuracy.

218 X Q. Did you test Exhibit X in case D?

A. To the same extent and in the same way.

219 X Q. Please put together case and heads M and piston D as you tried the same.

A. I can do so by inserting the shorter spindle, which I have in my hand, in the piston. The spindle of piston D will not allow the head to be put upon the case, as it is too long.

220 X Q. The spindle of piston D is all right in defendant's meter, is it not?

A. Yes.

221 X Q. Why did you have to change the spindle in adapting it to case M and heads M?

A. So as to get a shorter spindle, and on account of the greater motion the ports had to be altered, and that necessitated closing the top of the head.

222 X Q. The top of the head is open at the centre in defendant's meter, is it not?

A. Yes.

222½ X Q. And closed in case and heads M?

A. Yes.

223 X Q. And the bottom in case and heads M is open at the centre and closed in defendant's meter, Exhibit D?

A. Yes.

224 X Q. Please explain why these differences were made.

127 A. Because if the hole in the top head was big enough to allow the central spindle to work the registering mechanism in Exhibit M, the hole would have been so large as to open some of the neutral chambers.

225 X Q. If the neutral chambers were so opened the water would flow from them directly into the outlet, would it not?

A. Yes.

226 X Q. You have testified, that to adapt the valves of figure 7 of the Nash reissue to a piston having the motion of that of defendant's meter it would have been necessary only to make the number of ports in the valve equal to the number of chambers in the piston. You would have had to arrange the ports so as to have secured the lateral pressure necessary to keep the piston up to the sides of the case, would you not?

A. Yes.

227 X Q. In the drawings, Exhibit Y, you show neither the top plate and porting therein of the defendant's meter nor the bottom plate of the Nash meter nor the inlet ports of either meter, do you?

A. No.

228 X Q. Exhibit L, the model produced as representing the device in "Kinematics," represents one of the modified arrangements suggested in the Nash reissue, page 3, lines 87 to 94, does it not?

A. It has the motion referred to in lines 91, 92, 93, and 94 of page 3.

229 X Q. You have stated that you have seen Exhibit S, which represents the arrangement of figure 10 of the Nash reissue, in operation. Did you test it as a meter; and, if so, how accurately did it measure the water?

A. I did not test it. I merely saw it go round, which it did with regularity.

128 230 X Q. Would the pistons of either figure 10 or figure 11, if made exactly according to the drawings, in your opinion operate as intended?

A. I don't think either of the drawings are working drawings, and possibly a servile copy of these drawings would not make an operative meter, but the inaccuracies are such as are usually met with in Patent Office drawings, English and American.

231 X Q. You have testified that while the Chapman device would not operate at all if the passage in the piston were closed up, the defendant's device would operate, though not quite so efficiently. The reason for this is simply that in defendant's meter there are two sets of discharge ports, is it not?

A. The reason for this is that in Chapman you stop up the whole discharge and in defendant's meter only half the discharge.

232 X Q. Suppose the passage in the piston of defendant's meter were closed by a web on the same plane as the top of the piston, would there be any discharge then from defendant's meter?

A. No.

233 X Q. In the drawings, Exhibit B C, you show only the outlet ports; is that so?

A. Yes.

Adjourned for lunch.

Resumed after lunch.

Redirect examination by Mr. BULL:

234 R. D. Q. You have testified that the commercial meter of complainant will take up wear when the points of the piston by use have been worn down, and have produced a meter, marked Exhibit U, which has been worn and which shows that this action has taken place. Will a similar action compensating for wear take
129 place in the meters illustrated in figures 3 and 9 of the reissue in suit?

A. Yes.

235 R. D. Q. Could or could not the pistons shown in figures 10 and 11 of the patent in suit be operated by an eccentric?

A. They could.

236 R. D. Q. Referring to the Chapman patent in evidence, what prevents the steam constantly entering through the entrance port in that engine from passing directly out through the exhaust port?

A. Merely the abutments *h h*.

237 R. D. Q. Do the abutments referred to in your last answer, like the radial slides in the Ortlieb patent, constantly divide the inflow from the outflow and form a wall of the pressure chambers?

A. Yes.

238 R. D. Q. What is the first definition given in Worcester's Unabridged Dictionary of the word "eccentric"?

Objected to as incompetent, irrelevant, and immaterial.

A. "1. A circle not having the same centre with another circle, when one lies within the other."

239 R. D. Q. Referring to the drawings being a part of the Galloway 1846 patent of record, are they in all respects accurate working drawings?

A. No; there are errors in the drawings. The ports are not quite symmetrical in the drawing. Some of the ports are in the right position, others are not.

240 R. D. Q. Are those drawings, in your opinion, sufficient to instruct a mechanic how to make an operative engine on that design?

A. I think so.

241 R. D. Q. Are the several figures of the reissue in suit
130 in your opinion, sufficiently accurate to instruct a mechanic how to make operative meters of the several designs described in the specifications?

A. Yes.

242 R. D. Q. Referring to the exhibit composed of the piston D and the cylinder and heads marked M, your attention has been called to the fact that in this exhibit there is a central hole in the center of the bottom plate and there is no central hole in the top plate, while in defendant's meter there is a central hole in the top plate and no central hole in the bottom plate. Might the central hole in that exhibit have as well been made in the top plate and the bottom plate made without a hole, so that the relation thereof would have been the same as in defendant's meter?

A. Yes; by cutting the central spindle of the piston shorter, so that its top is even with the top of the piston and then carrying the shaft of the counter-mechanism in a spider within a hole of the proper size and then using the same crank now on Exhibit M.

243 R. D. Q. Is or is not, in your opinion, the function of the ports in any way changed by having a central hole in the bottom plate instead of the top, and is there any other reason for arranging it as shown in the exhibit except the convenience of attaching the registering mechanism and driving it thereby?

A. The function of the parts is in no way altered and the arrangement was adopted merely for convenience of attaching the registering device.

244 R. D. Q. You have testified that if the central web of defendant's piston were made solid the meter would still operate; would the piston still contain "internal water passages" after the web had been made solid, in your opinion?

A. It would, undoubtedly.

245 R. D. Q. I place in your hands a copy of "The Engineering
131 News," or American Contract Journal, dated New York, Saturday, December 25th, 1886, vol. 16, No. 152, and call your attention to the paragraph on page 428, beginning as follows:

"A step of great importance has been taken in the combination of a casing and one piston in such a manner that the piston may move within its case dependent upon no journal or bearings."

Who, in your opinion, was the first to take this "step of great importance"?

A. As I understand the meter art, Nash was the first one to produce a meter to which this description is applicable.

246 R. D. Q. What meter do you understand to be referred to in that paragraph, the first sentence of which I have just quoted?

A. I understand that the "Crown" meter invented by Nash and manufactured by complainant was the one referred to.

Recross examination:

247 R. X Q. Referring to your answer to cross-interrogatory 211, is there not in defendant's meter a possible play of the piston of

about an eighth of an inch toward and from the centre of the case?

A About an eighth.

HENRY L. BREVOORT.

Adjourned till Wednesday, the 10th inst., at 11 a. m.

132 NEW YORK, *Oct.* 10, 1888.

Adjourned till October 13th, at 11 a. m.

NEW YORK, *Oct.* 13, 1888.

Met pursuant to adjournment, and the examination of witnesses herein on behalf of complainant was continued as follows:

HENRY L. BREVOORT, being recalled, testifies as follows in answer to interrogatories propounded to him by J. EDGAR BULL, Esq., complainant's counsel:

Complainant's counsel offers in evidence file-wrapper and contents of application on which letters patent No. 211,582, Jan. 21, 1879, to Lewis H. Nash, assignor to National Meter Co., were granted, and the same is marked Complainant's Exhibit D E, file-wrapper and contents of Nash original patent, Oct. 13, 1888.

Complainant's counsel offers in evidence file-wrapper and contents of application on which letters patent No. 324,503, August 18, 1885, to James A. Tilden, assignor to Hersey Brothers, were granted, and the same is marked Complainant's Exhibit F G, file-wrapper and contents, Tilden patent of August 13, 1885, Oct. 13, 1888.

Also file-wrapper and contents of application on which reissue letters patent No. 107,888, of Nov. 2, 1886, to James A. Tilden, assignor to Hersey Meter Co., were granted, and the same is marked Exhibit H I, Tilden reissue, Oct. 13, 1888.

136 Defendant's counsel makes timely objection to the introduction of all said exhibits on the ground that they were incompetent, irrelevant, and immaterial.

248 Q. If you have caused to be made an illustrative model of the engine described in the patent to Chapman of record, please produce the same, that it may be offered in evidence.

A. I have. I now produce the model. It is an illustrative model made of wood, and illustrates, I think, correctly the operation of the engine. For the sake of convenience in making the model, the abutments have been arranged to be moved by a cam within instead of without the engine, and the annular space in which the piston moves is made in section rectangular instead of circular. These differences are immaterial in this connection.

Said model is offered in evidence and marked Complainant's Exhibit J K, Chapman engine, Oct. 13, 1888.

249 Q. Are the ports in the Chapman engine controlled or un-

controlled, in your opinion, as you have employed that word in your previous deposition?

A. They are uncontrolled, being always open to the flow of the steam to and from the engine.

250 Q. Will you please produce, that they may be offered in evidence, drawings illustrating the exhausts of the Crown meter and of defendant's meter?

A. I now produce the drawings, and the two arrows in each figure show the course of the exhaust.

Said drawings offered in evidence and marked respectively Complainant's Exhibits L M and N O, Brevoort exhaust drawings, October 18, 1888.

(Here follow diagrams marked pp. 133 & 134)

Objected to as inaccurate.

137 251 Q. In answer to cross-questions 219, 220, and 221, you have referred to a "shorter spindle," which was employed when the piston D was put in the case and heads M. Please produce that spindle, so that it may be offered in evidence.

A. I do so.

Said spindle offered in evidence and marked Complainant's Exhibit P Q, Brevoort spindle, October 13, 1888.

252 Q. Referring to the drawing which you have produced to illustrate the exhaust of the Crown meter, marked L M, does this drawing properly illustrate the course of the exhaust water through said piston and meter case? Please also explain how the course of the exhaust is illustrated in that drawing.

A. The drawing is what might be called a development on a plane of the passage. In the meter the arrow coming from the lower part of the chamber being exhausted would curve up from the paper and have its exit at the point shown. So with the other arrow, the passage being spiral.

Another sketch has been prepared, in which the parts not on the plane of the cross-section of the piston are shown by dotted lines, the heads being shown in elevation or in full front view, and the dotted arrows representing the passages being dotted, except where they come upon the plane of the cross-section of the piston. In mechanical drawing the ordinary method of showing parts not on the plane of the cross-section is to show such parts by dotted lines.

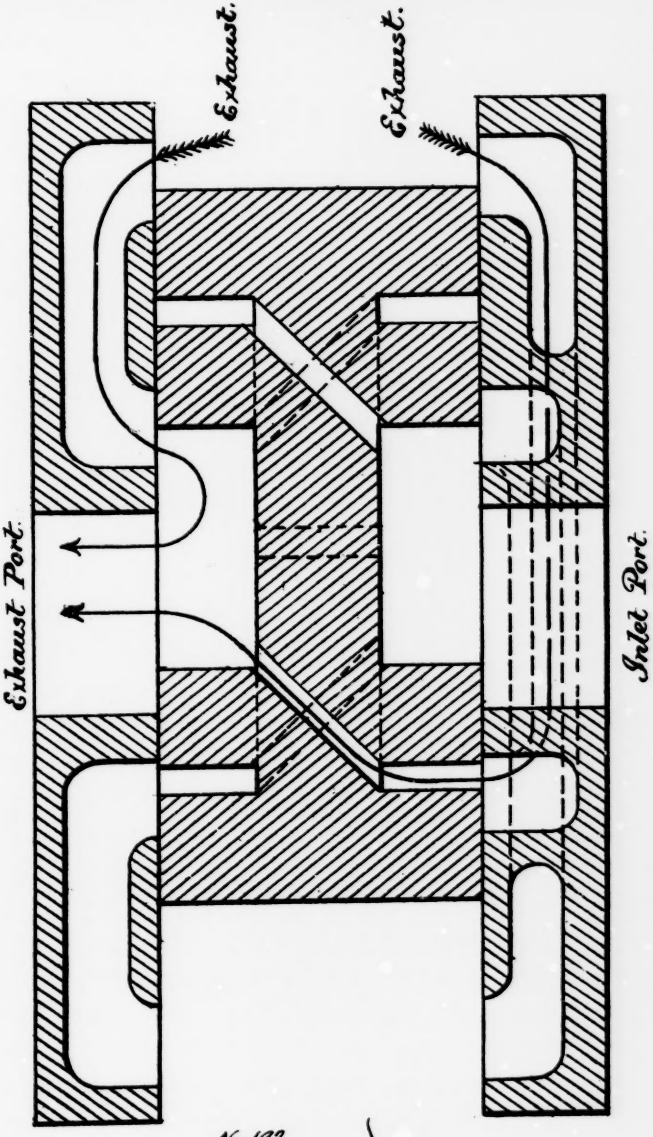
Said last-named drawing is offered in evidence and marked Complainant's Exhibit Brevoort Drawing R S, October 13, 1888.

(Here follows diagram marked p. 135.)

Counsel for defendant objects to this Exhibit R S, as well as L M, as unintelligible, inaccurate, and misleading.

138 Complainant's counsel offers in evidence an article from The Artizan, a monthly publication published in London,

Exhibit L-M.



No. 192.
Natl Meter Co.
v.
Bd Water Comrs
} p. 133

Exhibit N-O.

No. 192.
Natl Meter Co. } p. 134
vs.
Bd. Water Comrs

Exhibit R-S.

No. 192.
Natl Meter Co.
vs.
Bd. Water Comrs
} p. 135.

England, in the number for November, 1849, page 243, referred to in defendant's answer, and the same is marked Complainant's Exhibit T U, Artizan article, October 13, 1888.

This publication is admitted to have been as stated, subject to defendant's right to verify the same.

Defendant's counsel agrees that he will not question the fact that Exhibit U was brought into its present shape by wear, unless he finds to the contrary, and secures leave to question that fact at least thirty days before the trial.

Cross-examination by Mr. FISH:

253 X Q. What prevents the steam from blowing through in the Chapman engine?

A. The body of the piston and the movable pivoted abutment.

254 X Q. Will you define "controlled" and "uncontrolled," as you have employed those words in your depositions? I ask this question with reference to your answer to interrogatory 249.

A. I define the expression by saying that a controlled *port* is one that is sometimes shut and sometimes open and through which the fluid is intermittently passed.

255 X Q. Are the ports in the engine shown in figure 3, plates XXII, opposite page 371, of Reuleaux's Kinematics, here in evidence, controlled or uncontrolled?

Objected to on the ground that if the figure referred to is to be used as an anticipation of the claims, or either of them, of
139 the patent in suit, proper foundation therefor has not been laid in the answer; and, further, on the ground that it is not proper cross-examination.

A. The drawing, figure 3, shows a rotary engine in which the piston is shown as a little wider than the port, and I suppose the port may be said to be controlled during the time the piston is passing over the port. As a matter of fact, this operation is performed in an incredibly short space of time—that is, during about only one-fortieth part of the whole rotation of the piston—and during this time the inlet and outlet ports are shut.

256 X Q. Are the ports in the form of Ortlieb engine shown in figure 4, plate XIX, opposite page 65, of Exhibit Kinematics, controlled or uncontrolled?

Same objection.

A. They are, in my opinion, uncontrolled, as the port is never shut, the port always having some opening, I guess about a fifth of its area, but it may be more or less.

257 X Q. Would it make any difference in either of the engines referred to in the last two questions whether the ports were ever closed or not?

A. In the Ortlieb engine, figure 4, I suppose it would work if the ports were closed by the piston, but it would be better for the engine not to close them, and I don't see very well how they could be closed by the piston. The engine shown in figure 3, plate XXII,

would blow through under any circumstances, and it is immaterial in that figure whether the port is covered or uncovered by the piston. The drawings are not working drawings, but are only diagrams of motions and are not to be considered as working drawings.

258 X Q. Your statement as to those drawings applies as well to the drawings of the Galloway structure shown on page 434 of Kinematics, does it not?

140 A. Yes.

De bene esse:

259 X Q. What does the drawing N O, which you have produced, represent—that is, what view of defendant's meter?

A. A vertical cross-section.

260 X Q. It does not represent, does it, "what might be called a development on a plane of the passages," with other peculiarities, which you state in your answer to cross-interrogatory 252 the drawing L M is supposed to represent in defendant's meter?

A. No; the ports shown are on a plane through the meter.

261 X Q. Neither the sketches L M or R S show a plane through the Crown meter, do they?

A. Yes; they show a plane through the Crown meter and parts on that plane, and also parts in front of it and behind it. More than the parts merely on the plane are shown in R S by the dotted lines, and the head plates are made full.

262 X Q. Are the ports of the engine in the Exhibit Artizan Article T U, which I now show you, controlled or uncontrolled?

A. I have never looked at the exhibit critically. The ports must be controlled to make the engine operative, I should think. I cannot tell from the drawing and description how the engine is ported or constructed as to details.

Redirect *de bene esse* without waiving objections:

263 R. D. Q. Are the ports in this Artizan engine controlled, in your opinion, by the piston itself?

A. In my judgment, they are not. The engine must have been arranged like Galloway (1846) engine, with a head plate or an equivalent therefor, because, as shown, if the ports were in the heads of the cylinder the device would not operate.

141 264 R. D. Q. Do either — the devices indicated at Fig. 3 of plate XXII and Fig. 4 of plate XIX, in Kinematics, have a plurality of separate inlet or exhaust passages?

A. No; they each have a single inlet and a single exhaust.

265 R. D. Q. Is the devices shown in said Fig. 3 of plate XXII an operative device?

A. No; it is not.

266 R. D. Q. Are the illustrations last above referred to on plates XIX and XXII anything more, in your opinion, or intended to be anything more than illustrations of mechanical motions?

A. That is all.

Recross:

267 R. X Q. Why is Fig. 3 inoperative?

A. Because the stream would blow directly through the engine after the piston had uncovered the exhaust ports until it had covered the inlet ports.

HENRY L. BREVOORT.

142 COMPLAINANT'S EXHIBIT TILDEN ARTICLE.

Water Meters.

By J. A. Tilden, mem. of the Boston Soc. of C. E.

(Read Nov. 17, 1886.)

It is the intention of this paper to sketch the development of the water meter as a mechanical device. All questions as to its value as a means of checking waste and as a method of equitably adjusting rates are not considered here, but may be said to be answered by the constantly increasing demand for an efficient and cheap meter.

The history of its development as a piece of mechanism may be traced in the Patent Office, and it is from the patent records of the United States, England, France, and Germany, and from a few scattered publications that the data of this article are taken. The observations submitted are the result of practical experience in a long series of experiments and are offered simply as opinions.

It is remarkable that upon a subject of such importance so little has been written. The same unprejudiced thought and study as has been given the steam and other engines is entirely wanting. It appears to have been studied only by inventors and experimenters who have carefully guarded their work and reserved their conclusions for themselves. Every other form of engine or motor (for a meter is but a special adaptation) has been fully elaborated, and there are many authorities upon every subject, theoretical or practical, connected therewith, while upon the water or fluid meter information as to its mechanical or operative details is almost entirely wanting. It was on this account that the patent records were searched as a record of experimental work. As to their value as a source of information or authority, it will be seen that each specification must be read with caution, as many conceptions therein described do not even reach the experimental stage, while by far the larger proportion are abandoned by the time the patent is printed. A search as to novelty should comprise, and in the United States Patent Office does comprise, not only the class of meters, but that of engines, motors, and pumps, and of specific parts. A task of
143 this kind is truly formidable, for to be complete it should comprise a search of record in all patent-granting countries.

The United States patents—class of meters—number at this reading five hundred and fifty-two; those of England and colonies nearly as many more, and the number is well approached by the sum of those of France, Germany, Belgium, and others. Here will be found

the names of well-known engineers who have considered the water meter worthy of their expert attention and who have produced some very excellent machines, while, on the other hand, it has decidedly suffered at the hands of the entirely inexpert and ignorant, who have succeeded only in shrouding it in a kind of mystery and in producing the common impression that a successful meter is about as unattainable as perpetual motion. While an enormous amount of money has been expended in experiments, the total number of patents probably representing but a part, only a small portion has been utilized in well-executed design, as shown by the very few efficient devices in the market. If this statement is true there must have been some special difficulty peculiar to the problem. It can be shown that if one element—that of cost—were eliminated, mechanical defects could be easily overcome. Efficient and cheap it must be in order to meet a demand which does not exist for a high-priced machine. It is the cost at which it must be produced which makes its duty and requirements in excess of almost any other automatic machine.

There are a number of excellent meters in use, whose operation may be said to be practically all that is desired, their limited application being not on account of any defect, but because of their high price, which arises from their size, weight, and cost of manufacture. It may be noted here that in a comparison of economy of meters durability and permanency are as great a factor as price.

Ideas of what constitue- efficiency vary with almost every water department. Special prominence is generally given to one particular feature, to the oversight of others of equal or greater importance. However, they average up about as follows: To be efficient a meter must be accurate within a permissible error under extremes of pressure and rates of flow of perhaps two per cent. in favor of either de-
144 partment or consumer, and must maintain this standard with a reasonable, or rather an unreasonable, degree of permanency. It must not materially or noticeably retard the flow or diminish the pressure, and should be able to pass, without stopping, clogging, or breakage, substances often carried along with the water, such as sand, sediment, pipe scale, etc. It must be able to withstand without damage water hammer caused by sudden closing, and in itself produce none, or make any noise from its working parts. Altogether, it must be compact, of non-corrosive material, inexpensive in repairs, and capable of standing abuse rather than use. It will be observed that a number of these requirements are not inherent in a measuring apparatus, but have been introduced by the defects of meters themselves.

Of the United States patents on meters two hundred and thirty-nine are of the piston type, one hundred and eighty-three are rotary, fifty are diaphragm, and eighty are oscillating. There are in addition a number of miscellaneous which admit of no large classification, such as those of the purely inferential and proportional type.

The reciprocating piston meter in its severally perfected forms is a practical measuring device, its efficiency being limited only on ac-

count of its large cost, arising from the expensive non-corrosive materials used in a necessarily bulky construction. The mechanical problems of a piston meter have been fairly met. It is required that a piston be forced by water controlled by a suitable valve device to traverse a cylinder and return to its starting point. The amount of water displaced or measured per stroke is equal to the area of the piston into the distance which it travels. Connected with a properly constructed counter or register, the mechanism is complete. According to the records it would appear that this class of meter was as near perfection thirty years ago as it is to-day. Of more than two hundred United States patents in this line, but two or three have met with popular favor and are able to meet the market at anything approaching the required price. The others, which in many instances show great ingenuity, have either misconceived the object sought for or utterly failed mechanically. Many large and costly meters have been designed under the impression that there were no good piston devices in use.
145 These, of course, although they may be efficient, are unavailable on account of their cost. The mechanical failures above mentioned are in most instances absurdities in the outset.

The best forms of the steam pump and other piston engines have their adaptation in more or less practical water meters. A special arrangement of the parts is made whereby the valve mechanism is entirely inclosed, and in such manner that there are no moving parts or connections outside the case. The duplex pump is represented in a double plunger meter in which a pair of double-acting plungers operate in conjunction with a pair of slide-valves. The single pump is represented in various forms of single-piston meters in which the valve gearing is operated by a supplemental piston and valve, or by weights, springs, etc. These and other modifications of reciprocating engines, while quite effective, are large and heavy, and consequently costly.

In order to come within the narrow limits of price, many attempts toward a reduction of size and weight have followed, and as a result some of the special requirements of a meter have been sacrificed. As an instance, in the attempt to make a single piston do the work of two an infinite variety of valve mechanisms have been devised with a view of obtaining the same easy movement found in the best double-piston meters. The uniform results have been that either the single-piston meter must be made large enough to equal in capacity the double piston or one of the following defects would ensue:

First. A mechanical noise caused by the striking of the moving parts, such as would come of the use of levers, weights, or springs in obtaining a reverse movement of the piston, or in the use of a supplemental valve, by the main or auxiliary piston striking its bunters.

Second. Water hammer caused by the checking of the flow at the instant of reversal of the main valve; or, third, if this is avoided by the use of poppet or open slide or piston valves, an annoying inaccuracy of registration ensues from the varying loss of water under

different conditions at the time the valve is changing. The double piston in one of its best forms operates upon precisely the same principle as the steam end of a duplex pump, the piston or plunger, as it is in the meter, moving a slide-valve which controls the water for the other plunger, which in turn operates a valve for the
146 first. All piston, valve, and connecting rods are dispensed with, as the valves are inside of the case and moved by direct contact with the plungers.

Attempts to lessen the high cost of this design have led to a great many experiments, such as the dispensing with the valves by the use of one piston as the valve of the other by placing one inside of the other, by placing them at right angles, by the use of one rotary or slide-valve operated with or without cranks, and in every other conceivable relation. All this with poor success in the way of a meter at a less cost, serving only to complicate parts or introduce some peculiar defect of its own.

Vibrating or oscillating pistons have been tried in many forms with little satisfaction, as the increased cost of construction overbalances the reduction in weight.

Flexible diaphragms have been substituted for the piston and combined with every valve gearing found in the piston and oscillating types, but still the diminution of size and weight is not found.

The opinion is submitted that almost any positive displacement device constructed on good mechanical principles and, of course, specially adapted for the work would be a mechanical success as a measuring apparatus, and would be a commercial success were it not for the rigorous lines drawn by the very limited price at which it must be produced and sold. In the attempt to meet this cost feature by a diminution in size overwork of one or more parts or a general overcrowding is the inevitable result, causing either rapid wear or some of the immediate annoying defects, such as mechanical noise, water hammer, stopping, small capacity, inaccurate or uneven registration, etc.

There is a large class of inferential meters which come under the head of rotaries; all measuring wheels, turbine screw, and reaction come under this class, as they infer that for a given number of revolutions a certain amount of water will pass. It can be seen and experience has proved that only an unsatisfactory approximation is the result. Many, however, are yet in use in England, Germany, and other foreign countries, as the piston meters made and in use there are very expensive. The purely inferential meters are those which infer that a certain amount of water will pass through
147 an orifice the size of which is controlled by the flow. Registration is obtained and figured from a recording gauge which is operated by a piston or other valve at the orifice. A degree of success has been obtained in this way on large pipes.

Proportional meters were among the earliest conceptions for the registering of water in large quantities. In these a relatively small portion is deflected from the main pipe and measured by positive displacement, the principle being that the fluid will divide propor-

tionally under relatively equal resistance. It has been found that on account of the varying retardation of the metered part under the different conditions of pressure and flow a regulating valve of great delicacy is required to deflect the proper quantity from the open pipe to the meter according to the reduction of pressure at the point of discharge. The serious defects are, first, the multiplication of error, which is in the same proportion as the unmetered part to the metered, and, second, any clogging or imperfect action of the regulator may put the entire amount through the meter or, under other conditions, none through it, and the whole through the pipe without registering. This plan, as yet, has met with little favor, and may be said to have scarcely gone beyond the experimental stage. Its entirely inferential character and great delicacy renders it a little more than a guessing machine.

A number of devices, such as tilting tanks, floats, and weighing wheels, are simple and effective where they can be used for delivering water without pressure into a tank, but, of course, are entirely unavailable for the market, as the introduction of a meter on a pipe must not reduce or affect the pressure.

A positive displacement rotary, in distinction from the turbine or screw-wheel type, has constantly been sought for as the solution of an efficient low-priced meter. The same observation applies here as in the reciprocating piston. Almost any reasonable well-constructed rotary piston will measure water if not overcrowded, but with few exceptions they would have to be made so large as to be unavailable or, if reduced in size, are sure to introduce the same defects as noted in the reciprocating meter. Friction and consequent wear and inaccuracy has been an almost unsurmountable obstacle in the path of a small piston rotary. Until within a few years the only device of this kind meeting with any degree of success
148 has been the double-piston rotary, and this at the expense of delicate and costly workmanship. The style referred to is on the same general principle as the double-gear piston found in several patterns of steam-engine pumps and blowers.

A step of great importance has been taken in the combination of a casing and one piston in such a manner that the piston may move within its case dependent upon no journals or bearings. The effect of this is so far to reduce friction and increase operative areas as to bring the meter within a very small compass. Were it not *not* one fault, one which is singularly developed as a special defect, the liability to stop by the wedging of a minute particle of sediment between one of the many contact surfaces offered by their peculiar design, this improvement would have proved the meter ultimatum. The introduction of this class of meters in western and other cities, where river water is used, and in many other places where the water contains a large amount of sediment, has necessarily been limited.

There has been a special effort towards the designing of a meter which shall remove the defects of uncertainity and unreliability so long characteristic of all rotaries without sacrificing any of the advantages obtained by the use of a non-rotating piston. This end is accomplished in a class of meters in which the piston is perfectly

free and loose in its case. It is confined in its path only by the pressure of the water in distinction to all others, which divide the case in such a manner that the piston is held in a rigid mechanical path. This feature enables the piston to ride over substances which would lock any rotary whose piston is mechanically confined or ru-t and wear out any reciprocating meter.

There is developed in all modification- of this class a self-compensating feature by which a seeming paradox is actually accomplished, the fit of the parts is improved by use. A small excess of pressure on one side of the piston serves to maintain its contact on the other, giving by continued service a fit superior to the best mechanical grinding. Acting as its own valve, it is perfectly balanced by the duplicate porting of the plates between which it runs. Too much importance cannot be attached to balancing the moving parts, especially in a high-speed meter, using the expression in the same way it would be applied to an engine.

The lifetime of a meter is determined by the wear of its parts, which in turn depends upon the friction. Tight fitting is to
149 be discouraged, as it is productive of friction and inaccuracy.

It is evident that in order to reduce a meter to the size required by a marketable price, the working parts must move with great rapidity, that is to say, if it is desired that a very small part do the work of a large one, it must, of course, move very fast. This means the use of a revolving piston in preference to a reciprocating. It is obviously impossible for a reciprocating piston to attain the speed in a non-elastic fluid that a continuous motion or revolving piston is able to reach. In view of this, it is thought that this rule will apply. All moving parts in a high-speed meter must be either balanced in action or compensating for wear. In the style of meter last referred to, this rule is applied to a marked degree. The principle involved is susceptible of many modifications. An illustration is found in a meter in which the piston—which is made of hard rubber on account of its lightness and great durability—moves in a circular path, but does not in any sense rotate on an axis, real or imaginary. It has six radial projections, which in turn enter six measuring spaces or recesses in the casing, which is also of hard rubber, and by dividing each into receiving and discharging spaces operates upon precisely the same principle as piston and cylinder displacement. Three of the six projections are at work in their respective recesses at a time, and the same relative side of each being, by the arrangement of the ports, open to the inlet, and the other side to the outlet, a continuous motion and flow is effected. At the same instant that one projection leaves its space another one on the opposite side commences to work. The piston carries a pin which drives a registering train, and as a certain uniform amount is discharged per revolution, proper gearing reduces it to cubic feet, the unit of measurement. It is believed that the improvement of a "free piston" so far reduces internal friction as to materially increase the efficiency of the rotary meter; the consequent gain in durability more nearly approaches the requirements of cost.

150 COMPLAINANT'S EXHIBIT C. June 2, 1888. S. M. H., Ex'r.

Received for record September 4th, 1878, and recorded in Liber J 23, page 136, of Transfers of Patents.

In testimony whereof I have caused the seal of the Pat-
[SEAL.] ent Office to be hereunto affixed.

W. H. DOOLITTLE,
Acting Commissioner.

Ex'd: F. C. T.

Assignment Before Patent.

Whereas Louis H. Nash, late of South Norwalk, Conn., but now of Brooklyn, in the county of Kings and State of New York, has invented a certain new and useful improvement in water meters;

And whereas the "National Meter Company," a corporation under the laws of the State of New York, having its business domicile in New York city and county, is desirous of acquiring the right to the invention and the letters patent to be obtained therefor:

Now this indenture witnesseth that, for and in consideration of ten dollars to me in hand paid, the receipt whereof is hereby acknowledged, I have assigned, sold, and set over and do hereby assign, sell, and set over unto the said National Meter Company all my right, title, and interest in and to the said invention, as fully set forth and described in the specification prepared and executed by me preparatory to obtaining letters patent therefor, and I do hereby authorize and request the Commissioner of Patents to issue the said letters patent to the said National Meter Company in accordance with this assignment.

151 I witness whereof I hereunto set my hand and affix my seal this twenty-first day of August, A. D. 1878.

LEWIS H. NASH. [SEAL.]

(Endorsement: Assignment before patent. No. —. Lewis H. Nash to National Meter Company of City of New York. Filed by Johnson and Johnson, Washington, D. C. Fee, $1, p'd.)

152 COMPLAINANT'S EXHIBIT F, BIRDSALL LETTER, JUNE 1, 1888. R. N. H., Ex'r.

From chief engineer Croton aqueduct, N. Y.

D. P. W., CHIEF ENGINEER OF CROTON AQUEDUCT,
31 CHAMBERS ST., NEW YORK, *May* 2, 1888.

National Meter Co.

GENTLEMEN: After 8 years' use of the Crown water meter, of which we now have 8,000, it has been found to be reliable, and in the many retests for ourselves and for consumers has always come within our rule of 2 per cent. variation, and generally in favor of the consumer.

Respectfully yours,

G. W. BIRDSALL,
Chief Engineer Croton Aqueduct.

Size and number.	Set.	Purposes.	Repairs made.	Consumption.	Tests made.				
					Date.	Meter.	Tank.	Outlet.	Per cent.
⅝-inch Crown meter, No. 24057	Sept. 4, 1884	Domestic	None	72,890 ft.	Sept. 2, 1884	10 ft.	620 lbs.	¼ in.	.4
					April 16, 1888	10 ft.	628 "	½ in.	.8
						10 ft.	620 "	¼ in.	.4
						5 ft.	306 "	⅛ in.	1.8
						2 ft.	123 "	1/16 in.	1.3
⅝-inch Crown meter, No. 34060	Jan. 1, 1886	Laundry, &c.	None	87,552 ft.	Dec. 31, 1885	10 ft.	620 lbs.	¼ in.	.4
					April 16, 1888	10 ft.	635 "	½ in.	1.9
						10 ft.	617 "	¼ in.	.9
						5 ft.	307 "	⅛ in.	1.4
						2 ft.	124 "	1/16 in.	.4
⅝-inch Crown meter, No. 13565	June 20, 1883	Domestic	None	53,629 ft.	June 20, 1883	10 ft.	622 lbs.	¼ in.	.1
					April 16, 1888	10 ft.	620 "	½ in.	.4
						10 ft.	612 "	¼ in.	1.8
						5 ft.	306 "	⅛ in.	1.8
						2 ft.	122½ "	1/16 in.	1.7
⅝-inch Crown meter, No. 16877	Nov. 22, 1883	Domestic	None	54,537 ft.	Nov. 21, 1883	10 ft.	632 lbs.	¼ in.	1.5
					April 16, 1888	10 ft.	633 "	½ in.	1.6
						10 ft.	626 "	¼ in.	.5
						5 ft.	308 "	⅛ in.	1.1
						2 ft.	124 "	1/16 in.	.4
⅝-inch Crown meter, No. 19232	Jan. 18, 1884	Stores, &c.	None	65,142 ft.	Jan. 17, 1884	10 ft.	626 lbs.	¼ in.	.5
					April 16, 1888	10 ft.	633 "	½ in.	1.6
						10 ft.	627 "	¼ in.	.7
						5 ft.	311 "	⅛ in.	.1
						2 ft.	120 "	1/16 in.	1.3

154	⅝-inch Crown meter, No. 11392	Dec. 6, 1882	Domestic	None	56,965 ft.	Dec. 2, 1882	10 ft.	310 lbs.	1/4 in.	.4
						April 16, 1888	10 ft.	618 "	1/2 in.	.8
							10 ft.	617 "	1 in.	.9
							5 ft.	311 "	1/4 in.	.1
							2 ft.	122 "	1/16 in.	2.1
	¾-inch Crown meter, No. 18603	Feb. 4, 1884	Man'f'g, &c.	None	56,754 ft.	Jan. 30, 1884	10 ft.	624 lbs.	1/4 in.	.2
						April 16, 1888	10 ft.	628 "	1/2 in.	1
							10 ft.	630 "	1 in.	1.2
							10 ft.	631 "	1/8 in.	1.3
	¾-inch Crown meter, No. 12358	July 10, 1883	Domestic	None	79,307 ft.	July 10, 1883	10 ft.	618 lbs.	1/4 in.	.8
						April 16, 1888	10 ft.	640 "	1/2 in.	2.7
							10 ft.	631 "	1/4 in.	1.3
							10 ft.	628 "	1/8 in.	.8
	1-inch Crown meter, No. 10606	March 6, 1883	Manufact'g	None	60,560 ft.	March 6, 1883	10 ft.	630 lbs.	1/4 in.	1.2
						April 16, 1888	10 ft.	630 "	1 in.	1.2
							10 ft.	628 "	1/2 in.	.8
							10 ft.	627 "	1/4 in.	.7
							10 ft.	624 "	1/8 in.	.2
	1½-inch Crown meter, No. 23232	July 8, 1884	Motor	None	141,942 ft.	July 7, 1884	10 ft.	629 lbs.	1/4 in.	1
						April 16, 1888	10 ft.	639 "	1 in.	2.5
							10 ft.	637 "	1/2 in.	2.2
							10 ft.	651 "	1/4 in.	1.3
							10 ft.	629 "	1/8 in.	1

BOARD OF PUBLIC WORKS—OFFICE, CITY HALL, PROVIDENCE, R. I., *April* 20, 1888.

Mr. John C. Kelley, president National Meter Co., 252 Broadway, N. Y.

DEAR SIR: In reply to your request of 3d instant I hand you a memorandum showing the result of a test of ten Crown water meters that had shown a use of over fifty thousand cubic feet.

Very respectfully,

CLINTON D. SELLEW, *Secretary.*

155 COMPLAINANT'S EXHIBIT H. June 7, 1888. R. N. H., Ex'r.

Letter No. 3.

HOBOKEN, N. J., *May* 11, 1888.

Mr. John C. Kelley, president National Meter Co., 252 Broadway, New York city.

DEAR SIR: At your request I have removed several $\frac{1}{2}''$ Crown meters that have been in use from two and one-half to three years, tested their accuracy, and taken them apart for the purpose of examination. No repairs whatever have been made upon these meters since they were attached, and no repairs are now needed, except cleansing.

You will see from the detailed record of tests attached that the amount of water that has passed through the meters varied from about 50,000 to 100,000 cubic feet.

Respectfully submitted,

CHAS. B. BRUSH,
Chief Engineer and Superintendent.

On May 1st, 1888, there were attached to the service mains of this company 2,014 Crown meters.

C. B. B.

Results of tests made on seven one-half Crown meters which have been in use from two and one-half to three years in the city of Hoboken, upon which no repairs have been made since the meters were attached and upon which no repairs are now needed, except cleansing.

No. 1. Meter No. 33469. Amount of water registered by meter, 49,692 cubic feet.

Test on	15	cu. feet run with		$\frac{1}{2}$	-inch outlet.	Correct.
"	1	"	"	$\frac{1}{4}$	"	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{8}$	"	Correct.
"	1	"	"	$\frac{1}{16}$	"	Gain, 2.4 per cent.

156 No. 2. Meter No. 33884. Amount of water registered by meter, 60,947 cubic feet.

Test on	10	cu. feet run with		$\frac{1}{2}$	-inch outlet.	Loss, 0.24 of 1 per cent.
"	1	"	"	$\frac{1}{4}$	"	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{8}$	"	Loss, 2.4 per cent.
"	1	"	"	$\frac{1}{16}$	"	Correct.

3. Meter No. 33811. Amount of water registered by meter, 97,964 cubic feet.

Test on	10	cu. feet run with		$\frac{1}{2}$	-inch outlet.	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{4}$	"	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{8}$	"	Loss, 2.4 per cent.
"	1	"	"	$\frac{1}{16}$	"	Gain, 0.8 of 1 per cent.

4. Meter No. 33466. Amount of water registered by meter, 80,043 cubic feet.

Test on	10	cu. feet run with		$\frac{1}{2}$	-inch outlet.	Gain, 0.16 of 1 per cent.
"	1	"	"	$\frac{1}{4}$	"	Gain, 2.4 per cent.
"	1	"	"	$\frac{1}{8}$	"	Gain, 2.4 per cent.
"	1	"	"	$\frac{1}{16}$	"	Gain, 4.8 per cent.

5. Meter No. 33837. Amount of water registered by meter, 69,934 cubic feet.

Test on	10	cu. feet run with		$\frac{1}{2}$	-inch outlet.	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{4}$	"	Loss, 1.6 per cent.
"	1	"	"	$\frac{1}{8}$	"	Correct.
"	1	"	"	$\frac{1}{16}$	"	Correct.

6. Meter No. 33851. Amount of water registered by meter, 62,869 cubic feet.

Test on	10	cu. feet run with		$\frac{1}{2}$	-inch outlet.	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{4}$	"	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{8}$	"	Loss, 0.8 of 1 per cent.
"	1	"	"	$\frac{1}{16}$	"	Correct.

7. Meter No. 33483. Amount of water registered by meter, 60,270 cubic feet.

Test on	10	cu. feet run with		$\frac{1}{2}$	-inch outlet.	Gain, 0.4 of 1 per cent.
"	1	"	"	$\frac{1}{4}$	"	Correct.
"	1	"	"	$\frac{1}{8}$	"	Correct.
"	1	"	"	$\frac{1}{16}$	"	Gain, 2.4 per cent.

CHAS. B. BRUSH,
Chief Engineer and Examiner.

157 *Letter No.* 4.

COMPLAINANT'S EXHIBIT I. June 7, 1888. R. N. H., Ex'r.

Copy of a test of Crown water meters made by the superintendent of the water works, Fall River, Mass., March 30, 1888.

FALL RIVER, MASS., *March 30th*, 1888.

John C. Kelley, Esq., President National Meter Co., 252 Broadway, New York.

DEAR SIR: The following are the results of tests of a few out of a large number of Crown meters taken out during the past month,

which meters have been in service since 1881. These represent a fair average of all the tests:

No. of meter.	Size.	Reading.	Percentage of variation for 5 cu.ft. of water on different-sized streams				Favor city or consumer
			$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{16}$ in.	$\frac{1}{32}$ in.	
5538	$\frac{1}{2}$ in.	37,520	.8	.8	.8	.64	Consumer.
5988	$\frac{1}{2}$ in.	33,549	1.48	1.48	1.48	1.64	Consumer.
5981	$\frac{1}{2}$ in.	42,238	1.32	1.32	1.32	1.64	City.
9147	$\frac{1}{2}$ in.	125,188	.16	.16	.16	.16	City.
6332	$\frac{1}{2}$ in.	77,373	.64	.64	.64	.8	Consumer.
7078	$\frac{1}{2}$ in.	59,590	.8	.8	.8	1.12	Consumer.
7094	$\frac{1}{2}$ in.	63,320	1.16	1.16	1.16	1.8	Consumer.

These tests were taken under two different pressures—40 lbs. and 70 lbs.—at several different times, with the same sized streams.

It is proposed during the coming season to have taken off for test all meters that have been in service five years or longer. During the past month twenty meters of various kinds have been condemned for failure in registering on small streams and replaced by Crowns.

Yours truly,

PATRICK KIERAN,
Superintendent.

COMPLAINANT'S EXHIBIT J. June 7, 1888. R. N. H., Ex'r.

Copy of test of Crown meters made at Rochester Water Works, N. Y.

ROCHESTER, N. Y., *May 10th*, 1888.

National Meter Co.

GENTLEMEN: The following Crown meters were tested on date of April 24th and 25th, 1888. They had never been moved or repaired from the date of setting. The following table correctly indicates the number of meter, date of setting, date of test, number of cubic feet passed during period, cubic feet run during test by weight, and percentage of error:

Number of meter.	Date of setting.	Date of test.	Number of cubic feet passed during period.	Cubic feet passed during test.	Error in parts of cu. feet.	Remarks.
						Stream. Stream.
½ in. 3898	Ap'l, 1883	April 24, 1888	267,500 5/10	12.00	0.00	½ in., 10 cu. ft., full, and 2 cu. ft., ¼ in., .0 per cent.
½ in. 5449	Nov., 1881	" "	437,685 6/10	10.50	0 5/10	½ in., 10 cu. ft., full, .5 per cent.
½ in. 3893	Sept., 1882	" "	158,412	9.80	0 2/10	½ in., 10 cu. ft., full, .2 per cent.
½ in. 3900	Nov., 1880	" "	207,754 4/10	12.60	0 5/10	½ in., 10 cu. ft., full, and 2 cu. ft., ¼ in., .5 per cent.
½ in. 5927	Nov., 1881	April 25, 1888	215,428 5/10	10.00	0.00	½ in., 10 cu. ft., full, .0 per cent.
½ in. 6015	Nov., 1880	" "	71,610 2/10	11.80	0 2/10	½ in., 10 cu. ft., full, and 2 cu. ft., ¼ in., .1 per cent.
½ in. 3503	Aug., 1880	" "	330,770 4/10	8.70	1 3/10	½ in., 10 cu. ft., full, 1.3 per cent.
½ in. 5038	Nov., 1881	" "	109,289 6/10	9.30	1 7/10	½ in., 10 cu. ft., full, .7 per cent.
¾ in. 5083	Nov., 1881	" "	599,949	9.00	1	¾ in., 10 cu. ft., full, 10 per cent.
½ in. 5040	Nov., 1881	" "	200,059 2/10	9.20	0 8/10	½ in., 10 cu. ft., full, .8 per cent.

I hereby certify that the foregoing test was made by me and is correct.

PATRICK FLEMING, *Supt. of Meters.*

The foregoing test was made by my direction, and I believe the same to be correct.

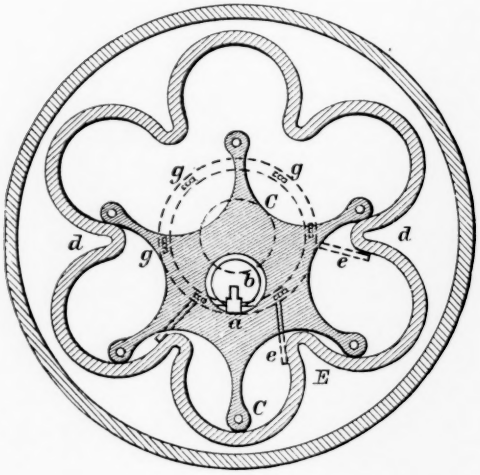
The Crown meters, of which we have a great number in use, about 1,600, have always performed excellent service in this city and have proved durable and substantially correct.

J. NELSON TUBBS, *Chief Engineer Water Works.*

159 COMPLAINANT'S EXHIBIT T U. October 13, 1888. R. N. H., Ex'r.

"The Artizan," vol. VII, page 243 of ——, 1849.

"The Orkney Rotary Engine."



We had the pleasure a short time since of inspecting, at Taplow, the working of Captain Fitzmaurice's rotary engine, which has been applied to propel a screw boat belonging to government. The engine is worked high pressure and non-condensing with a locomotive boiler, and at 480 revolutions per minute is estimated at 16 horse power, though we should feel no positive confidence in anything short of the application of a friction brake for arriving at the actual power exerted by the engine.

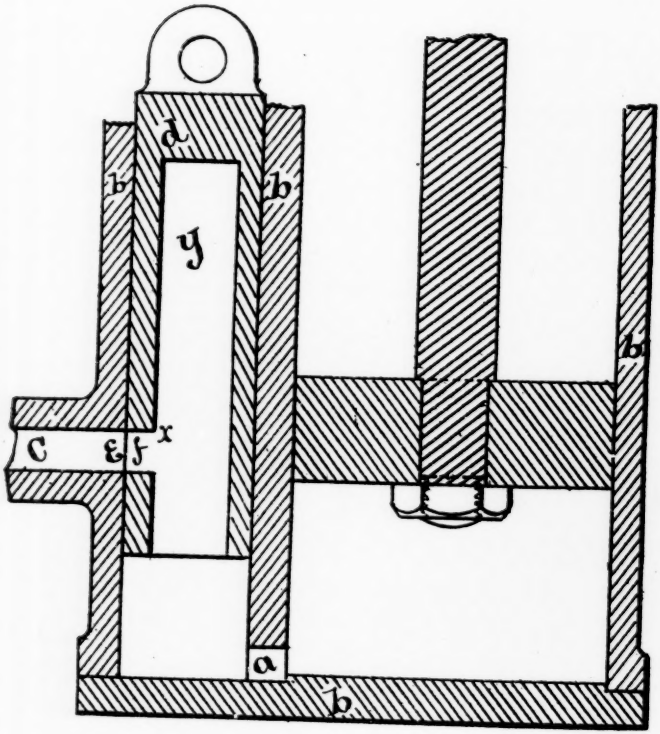
The boat is a very heavy one and not at all adapted for
160 speed, nevertheless she is propelled at from seven to eight miles per hour. The accompanying sketch will give an idea of the construction of the engine. There are six cells in the outer shell, *d d*, which are bored out and the junctions slotted to the same curves as the piston *a*. This piston is free to turn on the crank pin *b*, which reaches across the shell and is in a piece with the crank shaft *c*, which protrudes through a stuffing box in the shell. Thus, supposing the crank to revolve, the piston moves with it, each of its six arms describing a circle within its cell.

The piston is represented with its lower arm at half stroke and moving to the left, the steam being admitted through the three slots *e e e* and being exhausted through *g g g*. Although it is not absolutely necessary, the outer shell is allowed to revolve with the inner piston, in order to do away with the vibrating, which is found to be

Complainants Exhibit.

Valve Sketch.

W. H. T. Spec. Ex.



No 192.
Natl Meter Co.
v
Bd Water Comrs
p. 162

very great when the shell is held stationary, but which is not felt in the least degree when it is free to revolve. What will probably startle our readers more than anything else is that the system of metallic packing, which has been so much relied on in other rotary engines, is here thrown overboard altogether, and dependence is placed merely on the contact of the rolling surfaces. Our experience of the engine is too slight to warrant our giving any opinion at present on its peculiarities, but we hope by next month to be able to throw more light on this novel invention."

161 Circuit Court, Southern District of New York.

NATIONAL METER COMPANY, Complainant,
against
THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, Defendant.

UNITED STATES OF AMERICA, *Southern District of New York*, } *ss.*:

I, Samuel M. Hitchco-k, an examiner duly appointed by the circuit court of the United States for the southern district of New York, do hereby certify that the foregoing are the proofs for final hearing taken before me in the above-entitled cause, on the part of the complainant, under and pursuant to the 67th rule of the Supreme Court of the United States, as amended.

I do further certify that I am not of counsel nor attorney for either of the parties nor in anywise interested in the event of said cause.

I further certify that Mr. J. Edgar Bull appeared on the part of complainant and Mr. Frederick P. Fish appeared on the part of defendant in the taking of said proofs.

SAMUEL M. HITCHCOCK,
Examiner U. S. Circuit Court, Southern District of N. Y.

(Here follows diagram marked p. 162.)

168 UNITED STATES PATENT OFFICE.

LEWIS HALLOCK NASH, of Brooklyn, assignor to the National Meter Company, of New York, N. Y.

Rotary Water-Meter.

Specification forming part of Reissued Letters Patent No. 10,806, dated February 8, 1887. Original No. 211,582, dated January 21, 1879. Application for reissue filed December 18, 1886. Serial No. 222,012.

To all whom it may concern:

Be it known that I, Lewis Hallock Nash, late of South Norwalk, Connecticut, but now of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful improvements in water-meters; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

To obtain accuracy of measurement in a water-meter with a construction specially adapted for durability of operation, and by which a positive displacement of the water is effected without impeding the flow and interrupting the pressure of the head, is the object of my invention.

Water-meters adapted with reciprocating pistons, while effecting accurate measurement, have the disadvantage of interfering with the flow, and as a consequence entail the loss of pressure in the flow.

In my improved meter I use a piston adapted to have an eccentric or side-rocking motion across the center of a cylinder-chamber to effect its division at two or more points into receiving and discharging spaces. The piston operates with two or more continually-changing points or lines of bearing or contact with two or more points or contact-bearings of the cylinder at different points at the same time, by which the receiving and discharging spaces of the cylinder are caused to continually change their volume with an unobstructed flow and a positive displacement of the water from the discharging-space of the cylinder by the rocking of the piston from one bearing-point to another across the chamber of the cylinder. With this eccentric or side-rocking action the piston also revolves around its own center, and both these movements are effected by the relative shape of the piston and cylinder and by the direct action of the water upon the piston; for, as the piston rocks from one bearing-point to another directly across the center of the cylinder it is at the same time revolved to effect the measurement of the water passing into and from the cylinder-spaces, and to accommodate this eccentric or side-rocking motion of the piston it must have a free or shift-

ing connection with the crank or mover of the registering mechanism.

The continually-changing points or lines of bearing of the piston and cylinder are formed by alternate projections and recesses, and the eccentric or side-rocking movement of the piston is governed by the extent of the projecting bearing-points and the depth of the recesses, so that in the rotation of the piston around its own center one or more projecting bearing-points of the piston will pass into corresponding recesses at one point of the cylinder and in contact with and over one or more projecting bearing-points of the cylinder at a different point, thereby always maintaining a direct contact of the piston and cylinder at two or more dividing points within the continually-changing cylinder-spaces, and obtain thereby a continuous flow without interfering with the pressure of the head.

The object of these continually-changing points or lines of contact at different parts of the piston and the cylinder, and of the continually-changing volumes of the receiving and discharging spaces formed thereby, is to allow the water to flow through a valve into and from these spaces, as they fill and discharge, without impeding its flow or lessening its force.

In this connection and for effecting this operation, the valve may be formed with and constitute a part of the piston; or it may be separate therefrom and controlled by a connection therewith.

The valve is arranged so that the cylinder-spaces on one side of the piston as it revolves have free inlet for the water through one set of the valve-ports, while the spaces on the other side of the piston have free outlets for the water through the other ports of the valve, causing the piston to move with the flow. In this operation the valve opens some and closes others of the ports in succession in such a manner as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the eccentric or side-
169 rocking and rotary movements of the piston, and thereby avoid any undue lateral pressure of the water upon the piston. This result is accomplished in a more satisfactory manner by increasing the number of the bearing-points or lines of the cylinder and piston, as shown in Fig. 3. When the valve is arranged within the piston, it is formed by inlet and outlet openings or ports in the ends of the piston, communicating by means of passages in or through the piston with the spaces of the cylinder. These end openings or ports communicate with corresponding openings or ports in the ends of the cylinder, which form the inlet and outlet ports thereof.

In the arrangement of the valve separate from the piston the latter has no inlet and outlet ports; but these are formed within a case communicating with the cylinder, and operate in the same manner with respect to the constantly-changing cylinder-spaces, and the action of such separate valve is the same as one formed within the piston, and its motion is controlled by any suitable free attachment with said piston.

The results of these different arrangements of valves are identical, and any suitable form of valve may be used that will operate with

a periodic relation to the movements of the piston, so as to give a uniform flow and a uniform pressure upon the working parts.

Referring to the drawings—

(Here follow diagrams marked pp. 163, 164, 165, 166, & 167.)

Figure 1 represents a vertical section of a water-meter embracing my invention; Fig. 2, a top view with the case removed, showing one of the cylinder-ports; Fig. 3, a similar view, the cylinder-head being removed, showing one form of the cylinder bearing lines or points in connection with the rotary and side-rocking piston co-operating therewith, and in which the valve is shown as being within the piston, as in Figs. 1 and two; Fig. 4, the rotary and side-rocking piston with its inclosed valve; Fig. 5, a partial side view of the same, showing the end ports communicating with the lateral passages; Fig. 6, a perforated device at the cylinder-chamber inlet-port adapted to form a close-wearing joint for the piston; Fig. 7, a vertical section of a modified form of meter, to illustrate the arrangement with the rotary and side-rocking piston of a valve separated therefrom, but controlled by the motions of said piston; Fig. 8, the arrangement of the inlet and outlet passages into and from the cylinder-chamber and a valve separated from the piston, taken on line *a a* of Fig. 7; Fig. 8^a, a section on line *b b*, and Fig. 8^b the separate valve. Figs. 9, 10, and 11 are modified forms of the cylinder-bearing points or lines and the corresponding forms of side-rocking and rotary pistons adapted for co-operation therewith, and Fig. 12 shows the direction of the line of pressure upon the piston in relation to its continually-changing motion and the divided cylinder-spaces.

The case I prefer to make in two parts, one, A, of which forms the head or base, and has the inlet and outlet passages, which communicate with the cylinder-chamber ports, while the other part, B, forms the inclosing-case and carries the dial mechanism.

The cylinder C is secured to the base in any suitable way, leaving a space, D, between its walls and the case B, which space communicates with the outlet-passage E, while the inlet-passage F communicates with the cylinder inlet-port by an opening or openings, G, in the base.

The case B may or may not be used; but when it is it serves to form the space D surrounding the cylinder, and to relieve the working parts from undue pressure. In Fig. 7 the construction does not require the inclosing-case.

The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses *a a'* and projections *b b'* of such form or configuration as to allow of the rotation of the piston not only upon its own axis, but around and across the center of the cylinder, and the space within the cylinder must be of such form and sufficiently larger than the piston H to allow it to have this compound motion. The object of this compound motion is to form bearing points or lines of contact of the piston with the cylinder-walls, on opposite sides

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5 Sheets—Sheet 1.

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ROTARY WATER METER.

No. 10,806. Reissued Feb. 8, 1887.

Fig. 1.

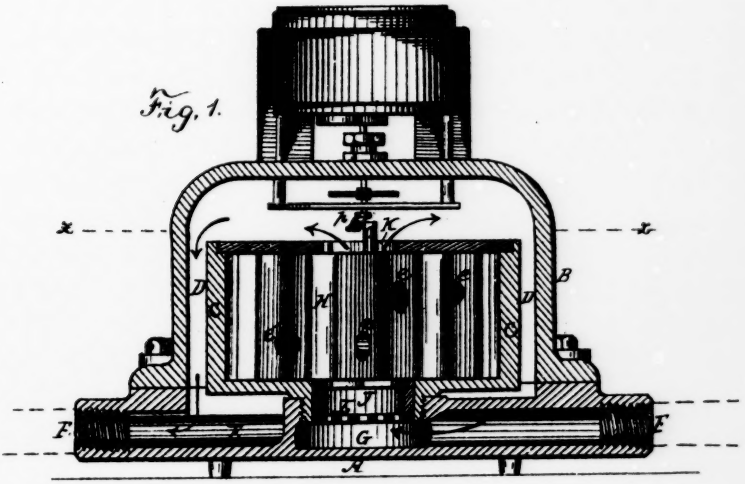
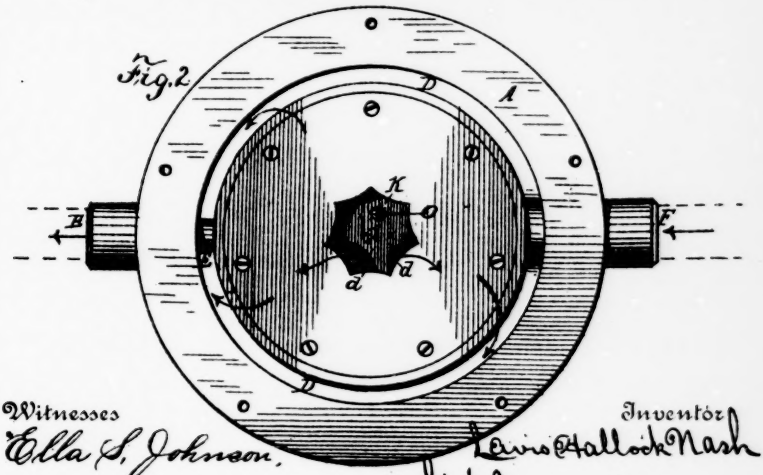


Fig. 2.



Witnesses
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5 Sheets—Sheet 2.

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Fig. 3.

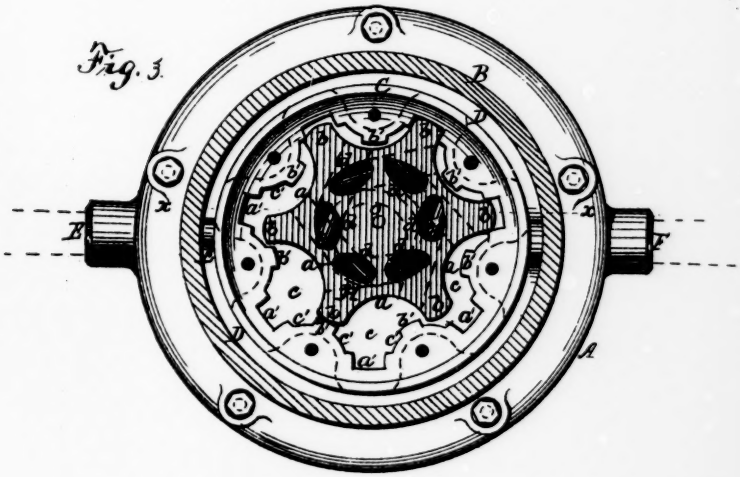

Fig. 4.

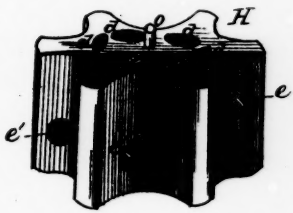

Fig. 5.

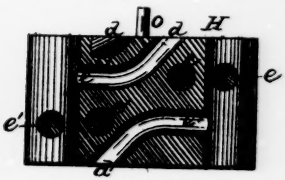

Fig. 6.

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natl. Meter Co.
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5 Sheets—Sheet 3.

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Fig. 7

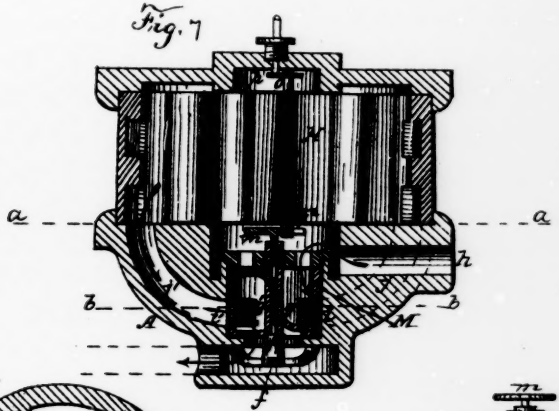

Fig. 8a

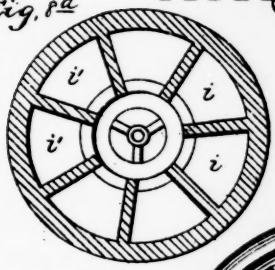

Fig. 8b

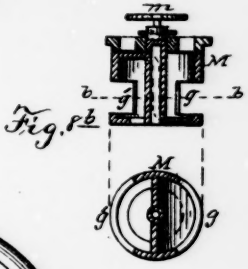

Fig. 8

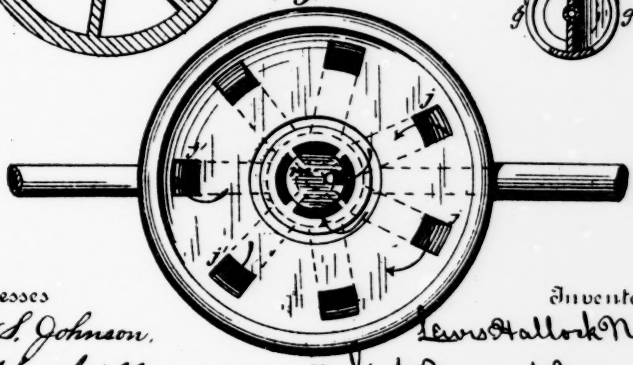

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Fig. 9.

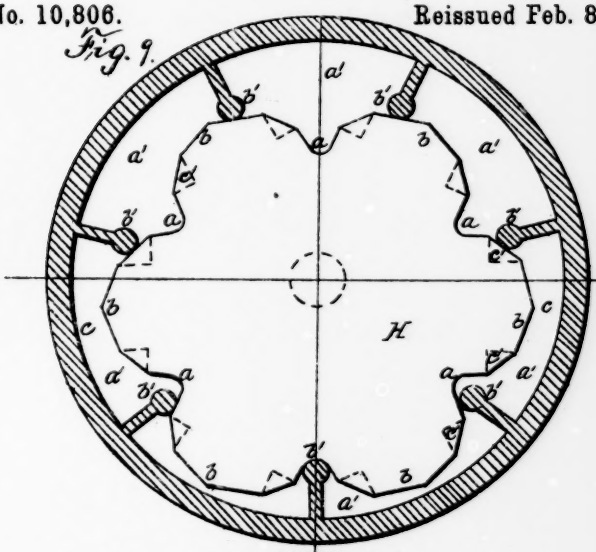

Fig. 10.

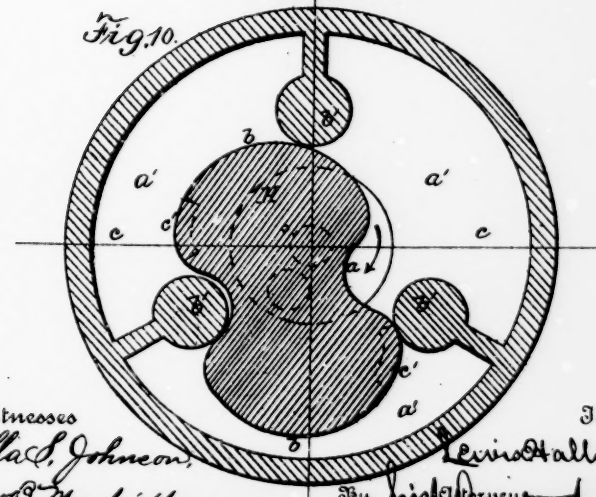

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Fig. 11.

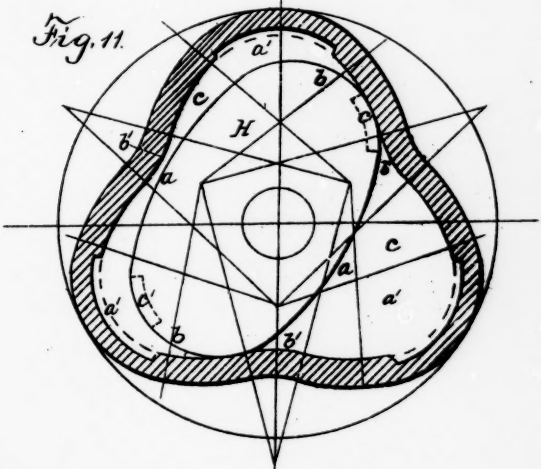
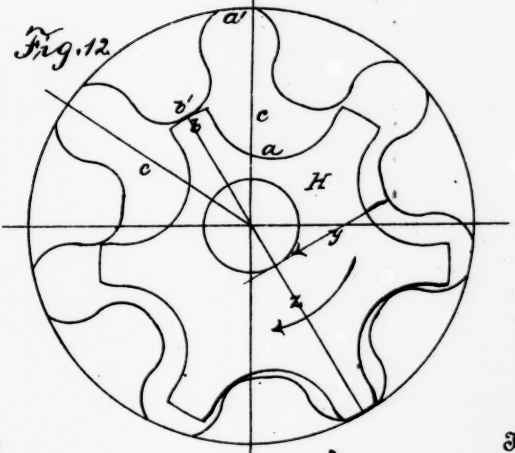


Fig. 12.



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thereof, at the same time, as shown in Figs. 3 and 12, whereby to divide the cylinder into receiving and discharging spaces. Of whatever form these alternate recesses and projections, they must be such that while they are in contact upon one side of the cylinder they must also at the same time have a contact at the opposite or a different side of said cylinder, and in this way divide the cylinder into spaces. In this contact it will be observed that upon one side of the cylinder and piston such contact takes place between a recess and projection, or intermediately between these points, while upon the opposite side such contact is made by corresponding projections, as shown in Figs. 3 and 12. Intermediately between these points of bearing and division it is advantageous that the cylinder-spaces *c* should communicate by the depression *c c'*, whereby to prevent the choking of the flow and insure a uniform action of the piston.

The compound motion of the piston and the contacting dividing-points are due to the fact that the piston has one or more less points of projection than the cylinder.

When the valve is formed within the piston, as shown in Figs. 1, 2, 3, 4, and 5, the heads of the cylinder have inlet and outlet ports J and K, which must have such form as to act in connection with ports in the piston to form a valve. As shown in these figures, the valve is formed within or is a part of the piston, and it consists of ports *d d'* in the ends of the piston, communicating with lateral passages *e e'*, which communicate with the spaces *c* of the cylinder, which form the receiving and discharging divisions.

The ports *d'* receive the water from the cylinder-port J and discharge it into the cylinder-spaces *c* through the lateral passages *e'*, while the ports *d* discharge the water from the cylinder-spaces through the passages *e*, the water flowing from the valve-ports *d* through the cylinder-port K, whence it passes into the surrounding space D and out through the discharge-pipe at E.

With this construction of valve I deem it advisable to use a self-adjusting perforated device, L, as the inlet-port, which is carried and held against the piston by the flow of the water against its perforated end, causing the opposite end to maintain a close joint with said piston to take up the wear.

The function of the valve is to regulate the flow of the water in and out of the spaces of the cylinder in such manner as to produce the compound rotation and cross movement of the piston; and this function can be made operative whether the valve be arranged within the piston, as described, or separate from and connected with it, as shown in Figs. 7 and 8 of the drawings, it being only necessary that the motion of the valve should be controlled by the compound motion of the piston in any arrangement; and I do not wish to confine myself to either of the specific arrangements of the valve shown, or to any specific construction of such valves in relation to the piston, so long as the valve and the piston co-operate to produce the results stated.

The valve shown in Figs. 7 and 8 consists of revolving cylinder

M, which by a partition divides the inlet from the outlet, and is supported by a fixed stem, *f*, within its seat. The water enters through the top of the valve by the ports *h* and passes out through a side port, *g*, in said valve into corresponding ports, *i*, in the valve-seat, thence through the passages *j j* into the filling-spaces *c* of the cylinder, and from the discharging-spaces it passes through the passages *j' j'* and the ports *i'* in the valve-seat through the port *g'*, and escapes through the bottom of the valve into the discharge-pipe.

Any of the various forms of the piston shown may be used with the separate valve by making the number of the inlet and outlet ports of the valve-seat to correspond to the number of the bearing projections of the cylinder. In the arrangement of the separate valve, it is operated by a crank or slotted disk, *m*, and a pin, *n*, Fig. 7, on the piston; or any other suitable connection may be made that will allow of the side movement of the piston. The piston is connected to the dial mechanism by a pin, *o*, engaging by a free action with or operating an arm, *p*, of the train of the interior gear, whereby the rotations of the piston are recorded by the usual dial-indices.

The recording device is mounted in a separate outside case and connected with an interior train by means of a shaft through a stuffing-box, as in ordinary dry-dial attachments.

It is required, in order to get the best results, that the valve should open and close its inlet and outlet ports in succession in such a manner as to keep the line of pressure as nearly as possible at right angles to the direction of the motion of the piston. By the "line of pressure" I mean a line connecting the points of division which separate the inlet from the outlet spaces *c* of the cylinder, as shown by the line *z* in Fig. 12; and by a "line of motion" I mean a line which is tangent to the path of the axis of the piston at any point of such path, as shown by the arrow *y* in said figure, and in this way these lines continually change their position as the piston rotates and rocks sidewise.

I prefer to make the piston of hard rubber; but it may be made of any suitable material, and either in one piece with the valve, or the latter may be made in the form of a plug and inserted within an opening in the piston.

I have described and prefer in practice that the piston shall have the compound motion described; but it is obvious that the piston may be fixed and the cylinder be made to have the relative compound motion. So, in like manner, both the cylinder and the piston may have a separate conjoint motion yet retaining the same relation to each other. In the use of the meter the inlet may become the outlet, and *vice versa*. It is also contemplated to use the machine as a motor or as a pump, and in the former case the power is taken from the piston through a crank-shaft or otherwise, and in the latter case the power is applied to the piston in the same manner.

The self-adjusting port device L (shown in Figs. 1 and 6) is adjustably seated within and forms said port, and has side walls,

with one end perforated and its other end open, and provided with a rim, which bears upon the end of the piston to effect the object stated.

An important feature of my invention embraces the combination, with a piston adapted to operate substantially as described, of a valve controlled thereby, irrespective of its specific construction or arrangement.

When an inclosing-case is used in connection with the cylinder, they are so arranged in relation to each other as to form an intermediate surrounding space, communicating with the end parts of the cylinder-chamber and with the outlet-port of the receiving end of the piston, for the purpose stated.

It will be seen that the connection of the piston with the registering mechanism is such as to allow of a free or shifting action to accommodate the side-rocking movements of the piston across the center of the cylinder-chamber and maintain a driving relation with the dial mechanism.

I do not claim, broadly, a piston for water-meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-
171 rocking movement within and upon continually-changing lines across the center of said chamber to effects its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, as a motor having a piston of substantially such construction and movement within a cylinder-chamber having such construction is shown and described in the English patent of Elijah Galloway, December 14, 1846, No. 11485; but what I do claim are said elements in combination with additional elements, as hereinafter specified, thereby limiting my claims to the novel features embraced in my meter.

I therefore claim—

1. A piston for water-meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually-changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, combined with a stationary top and bottom end plate in said cylinder-chamber, fitted to make easy-working joints with the respective ends of said piston, and with valves to coact with the piston in receiving and discharging water.

2. A piston for water-meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking motion within and upon continually-changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, combined with a top and bottom end plate in said cylinder-

chamber, and with means, substantially as described, by which the water is caused to flow over both ends of said piston.

3. A piston for water-meters, pumps, and motors provided with internal water-passages, and having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually-changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet.

4. A piston for water-meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing-points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually-changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, said piston having a free movement within said cylinder, controlled only by the shape of the cylinder, the shape of the piston, and the flow of water through the meter.

5. A piston for water-meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking motion within and upon continually-changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, said piston being formed of hard rubber and having a free movement within said cylinder controlled by the shape of the piston, the shape of the cylinder, and the flow of the water through the meter.

6. A piston for water-meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually-changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, combined with ports controlled by said piston itself in its motion within said chamber.

7. The piston of a water meter, pump, or motor constructed with alternate recesses and bearing points or projections *a* and *b*, and a cylinder-chamber having alternate wall-recesses and bearing points or projections *a'* and *b'* adapted to intermatch with each other at one or more bearing-points at one side of the cylinder and allow the projections of each part to bear upon and to pass each other at two or more points at a different side of the chamber, to allow the piston to revolve while it also rocks in constantly changing lines across the center of the cylinder-chamber for the purpose stated.

8. The piston of a water-meter adapted to have an eccentric or side-rocking movement across the center of the cylinder-chamber

and a revolving motion, combined with a registering mechanism by means of a free or shifting connection acting with the continually-changing side-rocking movements of the piston while maintaining a driving relation with the dial mechanism.

9. The combination, with a piston having an eccentric or side-rocking motion across the center of the cylinder-chamber and a revolving motion around its own center to divide the cylinder at two or more bearing-points on its sides, of a valve controlled by the movements of said piston and adapted to open and to close receiving and discharging ports in succession to effect the purpose stated.

172 10. A rotary piston having a valve formed therein by opposite end ports or depressions, and adapted to act in connection with receiving and discharging ports or passages in the cylinder-chamber to form a valve and piston into and through which the water entering at the inlet-cylinder end ports passes through one end of the valve into the cylinder on one side thereof, and, re-entering the valve from the other side of said cylinder, passes out at the opposite end ports of said valve, to effect the purpose stated.

11. A rotary valve piston having opposite end ports $d\,d'$, communicating with the piston sides by diagonal passages $e\,e'$, in combination with a cylinder having receiving and discharging ports communicating with said opposite valve end ports and with the receiving and discharging spaces of said cylinder, whereby said valve opens some and closes others of its ports in succession, and to effect the equalization of the pressure of the water at right angles to the direction of the side rocking and rotary movements of the said valve-piston, as stated.

12. The inlet device L, having side walls, a perforated end, and an open-end bearing-rim seated adjustably in and forming the inlet-port J of the cylinder-chamber, in combination with the rotary piston, against one end of which the said device bears, for the purpose stated.

13. The spaces or recesses c' in the walls of the cylinder, between the bearing-points b' and the recesses a', in combination with the piston having alternate bearing points and recesses, whereby to prevent the choking of the flow and insure a uniform action of a piston adapted for operation with a side-rocking motion across the center of the cylinder and a rotary motion around its own center.

In testimony that I claim the foregoing I have affixed my signature in the presence of two witnesses.

LEWIS HALLOCK NASH.

Witnesses:
H. W. BRINCKERHOFF.
WILLIAM C. WESTERVELT.

178 UNITED STATES PATENT OFFICE.

LEWIS H. NASH, of Brooklyn, assignor to National Meter Company of New York, N. Y.

Improvement in Rotary Water-Meters.

Specification forming part of Letters Patent No. 211,582, dated January 21, 1879; application filed September 4, 1878.

To all whom it may concern:

Be it known that I, Lewis H. Nash, late of South Norwalk, Connecticut, but now of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful improvements in water-meters; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

To obtain accuracy of measurement in a water-meter, with a construction specially adapted for durability of operation, and by which a positive displacement of the water is effected without impeding the flow and interrupting the pressure of the head, is the object of my invention.

Water-meters adapted with reciprocating pistons, while effecting accurate measurement, have the disadvantage of interfering with the flow, and as a consequence entail the loss of pressure in the flow.

In my improved meter I use a piston adapted to have an eccentric or side-rocking motion across the center of a cylinder-chamber, to effect its division at two or more points into receiving and discharging spaces. The piston operates with two or more continually-changing points or lines of bearing, or contact with two or more points or contact-bearings of the cylinder at different points at the same time, by which the receiving and discharging spaces of the cylinder are caused to continually change their volume with an unobstructed flow and a positive displacement of the water from the discharging-space of the cylinder by the rocking of the piston from one bearing-point to another across the chamber of the cylinder. With this eccentric or side-rocking action the piston also revolves around its own center, and both these movements are effected by the relative shape of the piston and cylinder, and by the direct action of the water upon the piston, for, as the piston rocks from one bearing-point to another directly across the center of the cylinder, it is at the same time revolved to effect the measurement of the water passing into and from the cylinder spaces; and to accommodate this eccentric or side-rocking motion of the piston, it must have a free or shifting connection with the crank or mover of the registering mechanism.

The continually-changing points or lines of bearing of the piston and cylinder are formed by alternate projections and recesses, and the eccentric or side-rocking movement of the piston is governed by the extent of the projecting bearing-points and the depth of the recesses, so that in the rotation of the piston around its own center one or more projecting bearing-points of the piston will pass into corresponding recesses at one point of the cylinder, and in contact with and over one or more projecting bearing-points of the cylinder at a different point, thereby always maintaining a direct contact of the piston and cylinder at two or more dividing-points within the continually-changing cylinder-spaces, and obtain thereby a continuous flow without interfering with the pressure of the head.

The object of these continually-changing points or lines of contact at different parts of the piston and the cylinder, and of the continually-changing volumes of the receiving and discharging spaces formed thereby, is to allow the water to flow through a valve into and from these spaces as they fill and discharge without impeding its flow or lessening its force.

In this connection and for effecting this operation the valve may be formed with and constitute a part of the piston; or it may be separate therefrom and controlled by a connection therewith.

The valve is arranged so that the cylinder-spaces on one side of the piston, as it revolves, have free inlet for the water through one set of the valve-ports, while the spaces on the other side of the piston have free outlets for the water through the other ports of the valve, causing the piston to move with the flow. In this operation the valve opens some and closes others of the ports in succession, in such a manner as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the eccentic or side-rocking and rotary movements of the piston, and thereby
179 avoid any undue lateral pressure of the water upon the piston. This result is accomplished in a more satisfactory manner by increasing the number of the bearing points or lines of the cylinder and piston, as shown in Fig. 3. When the valve is arranged within the piston, it is formed by inlet and outlet openings or ports in the ends of the piston, communicating, by means of passages in or through the piston, with the spaces of the cylinder. These end openings or ports communicate with corresponding openings or ports in the ends of the cylinder, which form the inlet and outlet ports thereof.

In the arrangement of the valve separate from the piston, the latter has no inlet and outlet ports; but these are formed within a case communicating with the cylinder, and operate in the same manner with respect to the constantly-changing cylinder-spaces, and the action of such separate valve is the same as one formed within the piston, and its motion is controlled by any suitable free attachment with said piston.

The results of these different arrangements of valves are identical; and any suitable form of valve may be used that will operate with a periodic relation to the movements of the piston, so as to give a uniform flow and a uniform pressure upon the working parts.

Referring to the drawings—

(Here follow diagrams marked pp. 173, 174, 175, 176, & 177.)

Figure 1 represents a vertical section of a water-meter embracing my invention; Fig. 2, a top view with the case removed, showing one of the cylinder-ports; Fig. 3, a similar view, the cylinder-head being removed, showing one form of the cylinder bearing lines or points in connection with the rotary and side-rocking piston co-operating therewith, and in which the valve is shown as being within the piston, as in Figs. 1 and 2; Fig. 4, the rotary and side-rocking piston with its inclosed valve; Fig. 5, a partial side view of the same, showing the end ports communicating with the lateral passages; Fig. 6, a perforated device at the cylinder-chamber inlet-port, adapted to form a close-wearing joint for the piston; Fig. 7, a vertical section of a modified form of meter, to illustrate the arrangement with the rotary and side-rocking piston of a valve separated therefrom, but controlled by the motions of said piston; Fig. 8, the arrangement of the inlet and outlet passages into and from the cylinder-chamber and a valve separated from the piston, taken on line *a a* of Fig. 7; Fig. 8ª, section on line *b b*, and Fig. 8ᵇ, the separate valve. Figs. 9, 10, and 11 are modified forms of the cylinder bearing points or lines and the corresponding forms of side-rocking and rotary pistons adapted for co-operation therewith, and Fig. 12 shows the direction of the line of pressure upon the piston in relation to its continually-changing motion and the divided cylinder-spaces.

The case I prefer to make in two parts, one, A, of which forms the head or base, and has the inlet and outlet passages, which communicate with the cylinder-chamber ports, while the other part, B, forms the inclosing-case and carries the dial mechanism.

The cylinder C is secured to the base in any suitable way, leaving a space, D, between its walls and the case B, which space communicates with the outlet-passage E, while the inlet-passage F communicates with the cylinder-inlet port by an opening or openings, G, in the base.

The case B may or may not be used; but when it is it serves to form the space D surrounding the cylinder, and to relieve the working parts from undue pressure. In Fig. 7 the construction does not require the inclosing-case.

The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses *a a'* and projections *b b'*, of such form or configuration as to allow of the rotation of the piston, not only upon its own axis, but around and across the center of the cylinder, and the space within the cylinder must be of such form and sufficiently larger than the piston H to allow it to have this compound motion. The object of this compound motion is to form bearing-points or lines of contact of the piston with the cylinder-walls, on opposite sides thereof, at the same time, as shown in Figs. 3 and 12, whereby to divide the cylinder into receiving and discharging spaces. Of whatever form these alternate recesses and projections, they must be such that while they are in contact upon one side of the cylinder

5 Sheets—Sheet 1.

L. H. NASH.

Rotary Water-Meter.

No. 211,582. Patented Jan. 21, 1879.

No. 192 Nat'l Meter Co. v. Bd. Water Comrs. p. 173.

Fig. 1.

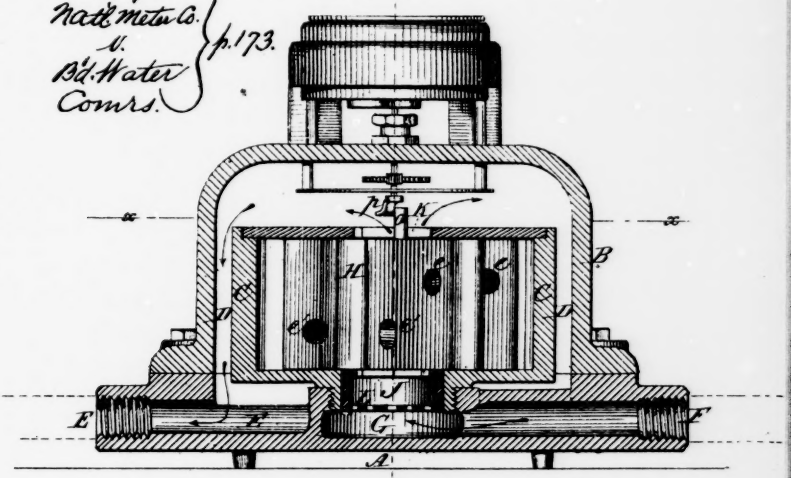
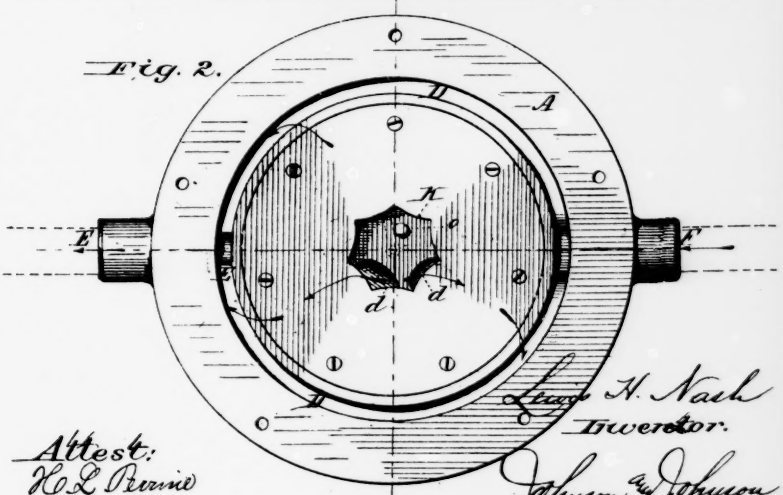


Fig. 2.



Attest:
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5 Sheets—Sheet 2.

L. H. NASH.

Rotary Water-Meter.

No. 211,582. Patented Jan. 21, 1879.

No. 192. Nash Meter Co. v. Bd. Water Comrs. p. 174.

Fig. 3.

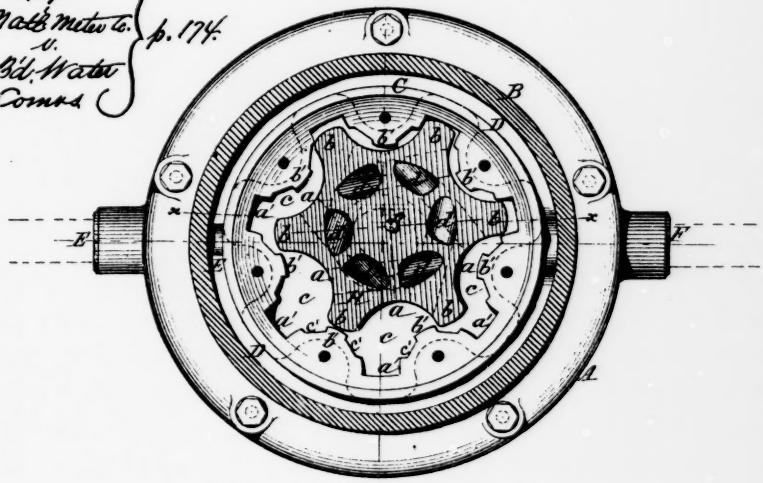


Fig. 4.

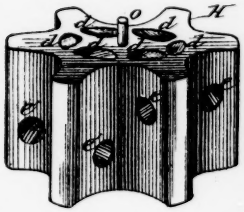


Fig. 5.

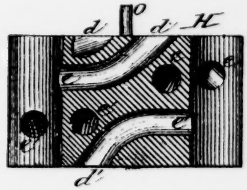
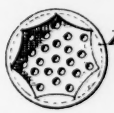


Fig. 6.



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No. 192.
Natl Meter Co
v.
Bd. Water Comm'rs
p. 175.

5 Sheets—Sheet 3.

L. H. NASH.

Rotary Water-Meter

No. 211,582. Patented Jan. 21, 1879.

Fig. 7.

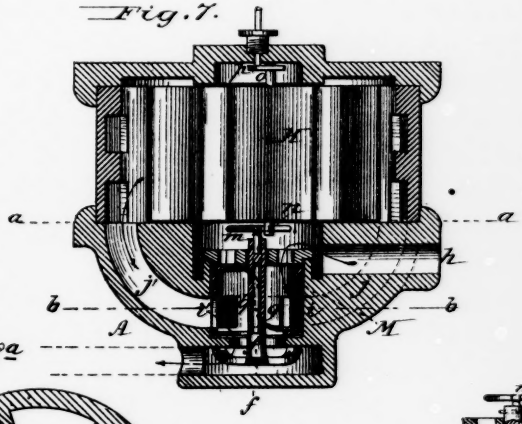


Fig. 8a

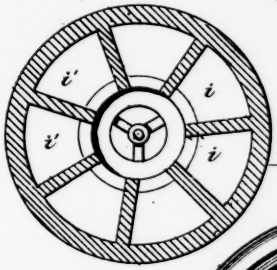
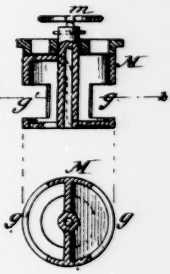
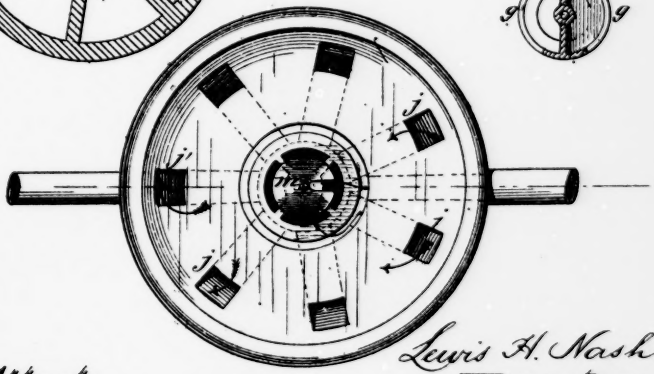


Fig. 8.

Fig. 8b





Attest:
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No. 192.
Nash Meter Co.
Bd. of Water Comm.
p. 176.

5 Sheets—Sheet 4.

L. H. NASH.

Rotary Water-Meter.

No. 211,582. Patented Jan. 21, 1879.

Fig. 9.

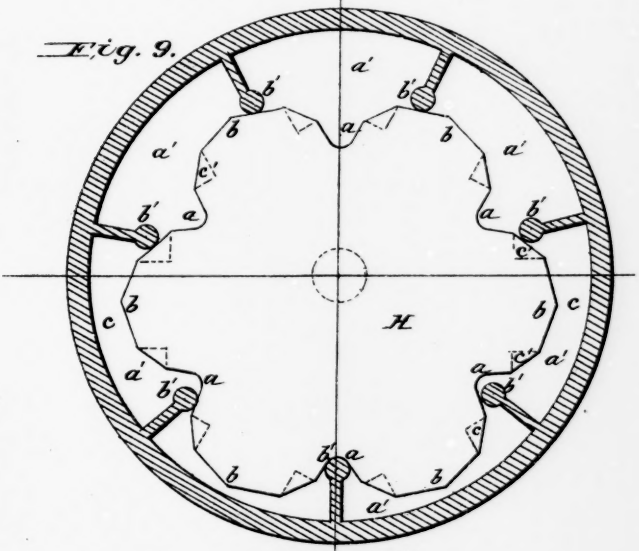
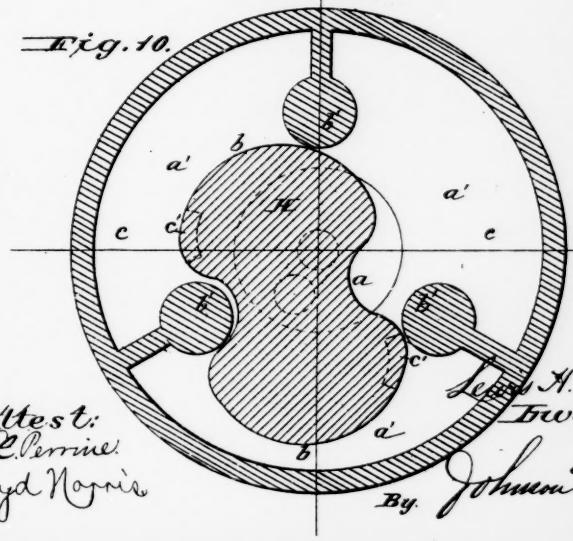


Fig. 10.



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5 Sheets—Sheet 5.

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Rotary Water-Meter.

No. 211,582. Patented Jan. 21, 1879.

Fig. 11.

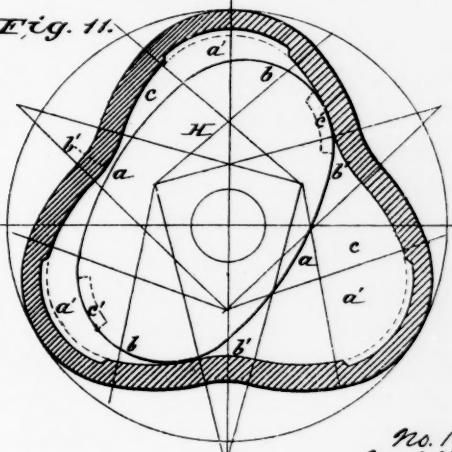

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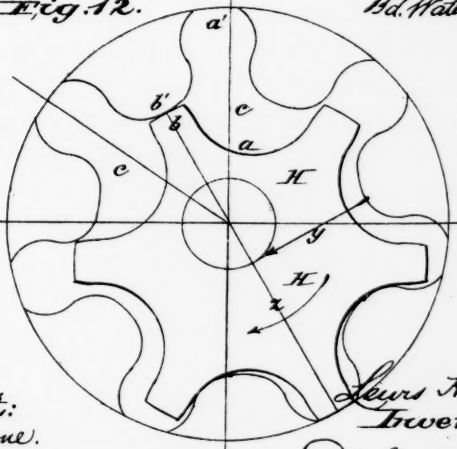
Fig. 12.



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they must also at the same time have a contact at the opposite or a different side of said cylinder, and in this way divide the cylinder into spaces. In this contact it will be observed that upon one side of the cylinder and piston such contact takes place between a recess and projection, or intermediately between these points, while upon the opposite side such contact is made by corresponding projections, as shown in Figs. 3 and 12. Intermediately between these points of bearing and division it is advantageous that the cylinder-spaces *c* should communicate by the depression *c'*, whereby to prevent the choking of the flow and insure a uniform action of the piston.

The compound motion of the piston and the contacting dividing-points are due to the fact that the piston has one or more less points of projection than the cylinder.

When the valve is formed within the piston, as shown in Figs. 1, 2, 3, 4, and 5, the heads of the cylinder have inlet and outlet ports J and K, which must have such form as to act in connection with ports in the piston to form a valve. As shown in these figures, the valve is formed within or is a part of the piston, and it consists of ports *d d'* in the ends of the piston, communicating with lateral passages *e e'*, which communicate with the spaces *c* of the cylinder, which form the receiving and discharging divisions.

180 The ports *d'* receive the water from the cylinder-port J, and discharge it into the cylinder-spaces *c* through the lateral passages *e'*, while the ports *d* discharge the water from the cylinder-spaces through the passages *e*, the water flowing from the valve-ports *d* through the cylinder-port K, whence it passes into the surrounding space D, and out through the discharge pipe at E.

With this construction of valve I deem it advisable to use a self-adjusting perforated device, L, as the inlet-port, which is carried and held against the piston by the flow of the water against its perforated end, causing the opposite end to maintain a close joint with said piston to take up the wear.

The function of the valve is to regulate the flow of the water in and out of the spaces of the cylinder in such manner as to produce the compound rotation and cross movement of the piston, and this function can be made operative whether the valve be arranged within the piston, as described, or separate from and connected with it, as shown in Figs. 7 and 8 of the drawings, it being only necessary that the motion of the valve should be controlled by the compound motion of the piston in any arrangement; and I do not wish to confine myself to either of the specific arrangements of the valve shown, or to any specific construction of such valves in relation to the piston, so long as the valve and the piston co-operate to produce the results stated.

The valve shown in Figs. 7 and 8 consists of revolving cylinder M, which, by a partition, divides the inlet from the outlet, and is supported by a fixed stem, *f*, within its seat. The water enters through the top of the valve by the ports *h*, and passes out through a side port, *g*, in said valve into corresponding ports — in the valve-seat, thence through the passages *j j* into the filling-spaces *c* of the cylinder, and from the discharging-spaces it passes through the pas-

sages *j' j'* and the ports *i'* in the valve-seat, through the port *g'*, and escapes through the bottom of the valve into the discharge-pipe.

Any of the various forms of the piston shown may be used with the separate valve by making the number of the inlet and outlet ports of the valve-seat to correspond to the number of the bearing-projections of the cylinder. In the arrangement of the separate valve it is operated by a crank or slotted disk, *m*, and a pin, *n*, Fig. 7, on the piston; or any other suitable connection may be made that will allow of the side movement of the piston. The piston is connected to the dial mechanism by a pin, *o*, engaging by a free action with or operating an arm, *p*, of the train of the interior gear, whereby the rotations of the piston are recorded by the usual dial indices.

The recording device is mounted in a separate outside case, and connected with an interior train by means of a shaft through a stuffing-box, as in ordinary dry dial attachments.

It is required, in order to get the best results, that the valve should open and close its inlet and outlet ports in succession in such a manner as to keep the line of pressure as nearly as possible at right angles to the direction of the motion of the piston. By the "line of pressure" I mean a line connecting the points of division which separate the inlet from the outlet spaces *c* of the cylinder, as shown by the line *z* in Fig. 12; and by a "line of motion" I mean a line which is tangent to the path of the axis of the piston at any point of such path, as shown by the arrow *y* in said figure; and in this way these lines continually change their position as the piston rotates and rocks sidewise.

I prefer to make the piston of hard rubber; but it may be made of any suitable material, and either in one piece with the valve, or the latter may be made in the form of a plug and inserted within an opening in the piston.

I have described and prefer in practice that the piston shall have the compound motion described; but it is obvious that the piston may be fixed and the cylinder be made to have the relative compound motion. So in like manner both the cylinder and the piston may have a separate conjoint motion, yet retaining the same relation to each other. In the use of the meter the inlet may become the outlet, and *vice versa*. It is also contemplated to use the machine as a motor or as a pump, and in the former case the power is taken from the piston through a crank-shaft or otherwise, and in the latter case the power is applied to the piston in the same manner.

The self-adjusting port device L (shown in Figs. 1 and 6) is adjustably seated within and forms said port, and has side walls, with one end perforated and its other end open and provided with a rim, which bears upon the end of the piston, to effect the object stated.

An important feature of my invention embraces the combination, with a piston adapted to operate substantially as described, of a valve controlled thereby irrespective of its specific construction or arrangement.

When an inclosing-case is used in connection with the cylinder

they are so arranged in relation to each other as to form an intermediate surrounding space, communicating with the end parts of cylinder-chamber and with the outlet-port of the receiving end of the piston, for the purpose stated.

It will be seen that the connection of the piston with the registering mechanism is such as to allow of a free or shifting action, to accommodate the side-rocking movements of the piston across the center of the cylinder-chamber and maintain a driving relation with the dial mechanism.

I claim—

1. A piston for water-meters, pumps, and motors having alternate bearing points or projections and recesses, adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within
181 and upon continually-changing lines across the center of said chamber, to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet.

2. The piston of a water-meter, pump, or motor constructed with alternate recesses and bearing points or projections *a* and *b*, and a cylinder-chamber having alternate wall-recesses and bearing points or projections *a'* and *b'*, adapted to intermatch with each other at one or more bearing-points at one side of the cylinder and allow the projections of each part to bear upon and to pass each other at two or more points at a different side of the chamber, to allow the piston to revolve while it also rocks in constantly-changing lines across the center of the cylinder-chamber, for the purpose stated.

3. The piston of a water-meter adapted to have an eccentric or side-rocking movement across the center of the cylinder-chamber and a revolving motion, combined with a registering mechanism by means of a free or shifting connection acting with the continually-changing side-rocking movements of the piston while maintaining a driving relation with the dial mechanism.

4. The combination, with a piston having an eccentric or side-rocking motion across the center of the cylinder-chamber and a revolving motion around its own center to divide the cylinder at two or more bearing-points on its sides, of a valve controlled by the movements of said piston and adapted to open and to close receiving and discharging ports in succession, to effect the purpose stated.

5. A rotary piston having a valve formed therein by opposite end ports or depressions, and adapted to act, in connection with receiving and discharging ports or passages in the cylinder-chamber, to form a valve and piston, into and through which the water entering at the inlet-cylinder end ports passes through one end of the valve into the cylinder on one side thereof, and, re-entering the valve from the other side of said cylinder, passes out at the opposite end ports of said valve, to effect the purpose stated.

6. A rotary valve-piston having opposite end ports *d d'*, communicating with the piston sides by diagonal passages *e e'*, in combination with a cylinder having receiving and discharging ports.

communicating with said opposite valve end ports and with the receiving and discharging spaces of said cylinder, whereby said valve opens some and closes others of its ports in succession, and to effect the equalization of the pressure of the water at right angles to the direction of the side-rocking and rotary movements of the said valve piston, as stated.

7. The inlet device L, having side walls, a perforated end, and an open-end bearing rim, seated adjustably in and forming the inlet-port J of the cylinder chamber, in combination with the rotary piston, against one end of which the said device bears, for the purpose stated.

8. The spaces or recesses c' in the walls of the cylinder, between the bearing-points b' and the recesses a', in combination with the piston having alternate bearing-points and recesses, whereby to prevent the choking of the flow and insure a uniform action of a piston adapted for operation with a side-rocking motion across the center of the cylinder and a rotary motion around its own center.

In testimony that I claim the foregoing I have affixed my signature in the presence of two witnesses.

LEWIS H. NASH.

Witnesses:
A. E. H. JOHNSON.
J. W. HAMILTON JOHNSON.

184 UNITED STATES PATENT OFFICE.

LEWIS H. NASH, of Brooklyn, assignor to National Meter Company, of New York, N. Y.

Improvement in Rotary Water-Meters.

Specification forming part of Letters Patent No. 211,769, dated January 28, 1879; application filed November 8, 1878.

To all whom it may concern:

Be it known that I, Lewis H. Nash, late of South Norwalk, Connecticut, but now of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful improvements in water-meters, of which the following is a specification:

In a patent bearing date January 21, 1879, No. 211,582, I have described and shown a piston of a water-meter adapted to have an eccentric or side rocking movement within and upon continually-changing lines across the center of the cylinder-chamber, to effect the division of said chamber at two or more continually-changing points on its sides into receiving and discharging spaces, which communicate with the inlet and the outlet, the said piston having also a revolving motion around its own center, to allow of the continuous passage of the water within said chamber from the receiving to the discharging spaces thereof. In this connection the piston is adapted for co-operation by means of a valve formed integral therewith, and

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2 Sheets—Sheet 2.

L. H. NASH.

Rotary Water-Meter

No. 211,769. Patented Jan. 28, 1879.

Fig. 3.

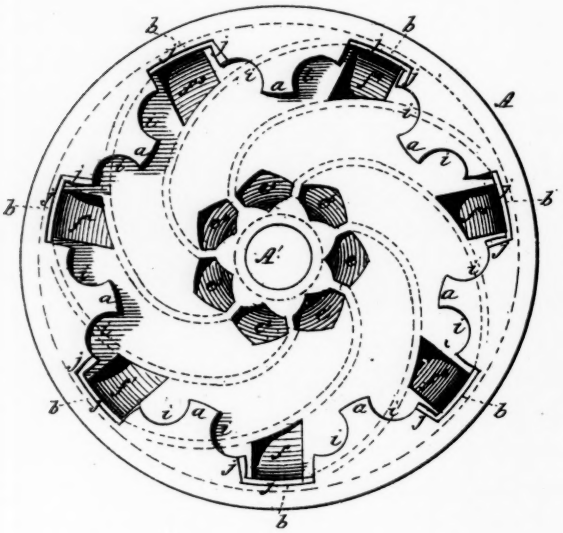
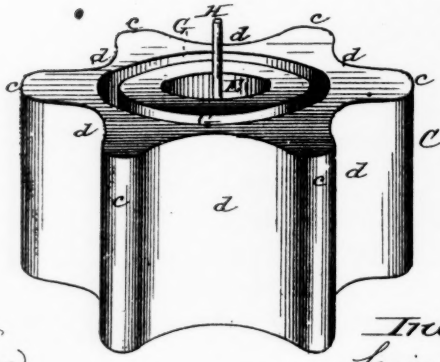


Fig. 4.



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Natl Meter Co.
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Bd Water Comrs.
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2 Sheets—Sheet 1

L. H. NASH.

Rotary Water-Meter.

No. 211,769 Patented Jan. 28, 1879.

Fig. 1.

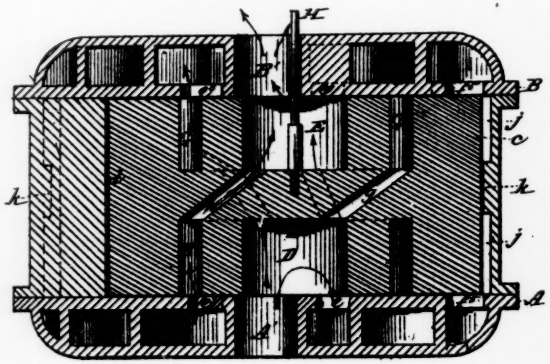
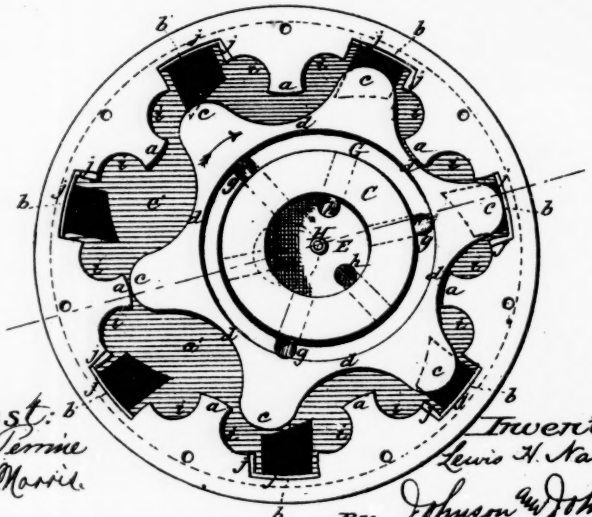


Fig. 2.



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through which the inflow and outflow takes place at opposite ends of the piston.

My present improvements embrace a construction and adaptation of a double-end valve and piston, and water-passages in the opposite cylinder-heads, by which I obtain both an inlet and an outlet port on each side of the piston, whereby a greater capacity of the valve is obtained, and at the same time maintain the balance of the pressure of the water on each side of the piston, and avoid friction and wearing. The walls of the cylinder are formed in such manner as to allow free passage of the water between the receiving-spaces of the cylinder on one side of the piston, and also free passage of water between the discharging-spaces on the other side of the piston, so as to cause the pressure of the water in the communicating spaces to be uniform throughout, and to prevent the retarding of the piston by avoiding choking of the water in the passages and spaces, which would be liable to cause such retardation. This construction is also such as to allow sediment and foreign substances to pass through the cylinder-chamber without interfering with the working of the piston. These are some of the advantages which my present improvements accomplish.

(Here follow diagrams marked pp. 182 & 183.)

Referring to the drawings, figure 1 represents a section taken through the inlet and outlet ends and the valved piston and cylinder of a water-meter embracing my invention; Fig. 2, a plan view of the meter with one of the heads removed, and showing the valved piston in the relation it occupies in dividing the cylinder-chamber into receiving and discharging spaces; Fig. 3, an inside plan view of one of the cylinder-heads, showing the inlet-valve ports and the outlet-ports therein; and Fig. 4, the valved piston, of peculiar construction of double-end ports.

The piston is constructed with a double-end valve formed therein, and adapted for co-operation with a cylinder-chamber having water-passages formed in its opposite inlet and outlet heads, so that in whatever position the piston may be the valve-space at one end of the piston will always communicate with the inlet-passage, and the valve-space at the other end of the piston will always communicate with the outlet-passage, of the cylinder-chamber during the continually-changing points of division of said chamber made by the movements of the piston.

The interior wall of the cylinder-chamber is formed by alternate projections *a* and recesses *b*, extending from the inner side of the inlet-head A to the inner side of the outlet-head B, while the piston has circumferential alternate projections *c* and recesses *d* of a relative shape, adapted to pass into the recesses *b* at one side of the cylinder, and over the projections *a* at the opposite sides thereof, as the piston is caused to rock sidewise across the center of the cylinder, to form continually-changing lines of bearing or contact at two or more points, to divide the said chamber into receiving and discharging spaces *a' c'*, Fig. 2, which continually change their volume, and into and from which the water has an unobstructed flow and a posi-

tive displacement without loss of pressure in said flow. Current with the rocking motion of the piston across the center of the
185 cylinder-chamber, to effect its division at two or more points, the piston has also a motion around its own center, to effect the measurement of the water passing into and from the cylinder-spaces, and both these movements of the piston are effected by the relative shape of the piston and cylinder and the direct action of the water upon the piston.

As the principle involved in this construction and operation is fully set forth in my said patent, a more detailed description thereof is deemed unnecessary in the presentation of the special improvements claimed herein.

The arrangement of the ports in both heads of the cylinder is alike, and it is by this means, in connection with a double-end valved piston, that the capacity of the valve is doubled. Each cylinder-head forms a shell with a series of ports therein, and a central opening having perpetual communication with spaces in the opposite ends of the piston-valve, and which central openings form the inlet-port A′ and the outlet-port B′ of the meter. Concentric with and near these central ports are ports $e\ e^1\ e^2\ e^3\ e^4\ e^5\ e^6$, corresponding in number with the cylinder-recesses *b*, and which communicate by curved passages with circumferential ports $f\ f^1\ f^2\ f^3\ f^4\ f^5\ f^6$, opening at said wall-recesses, as shown in Fig. 3. These curved passages stand in reverse positions in the heads—that is, they curve one way in the inlet-head and in the opposite direction in the outlet-head, so as to direct the water into the chamber on opposite sides of the piston and in the same direction with its revolving motion, so that both heads have corresponding ports, in which some of one set, *e*, &c., communicate with central valve-spaces in the piston during its movements, and the other set, *f*, opening directly into the cylinder-chamber. Between and joining these heads the piston works in its side rocking and rotary movements, so as to constantly change its communication with the ports $e\ e^1\ e^2$, &c., but not with the inlet and outlet ports of said heads.

The valve in the piston C is of peculiar construction, and consists of an annular central space, D and E, in each end, of equal depth and area, and an annular space, F and G, surrounding each central space, and of equal depth and area. These annular spaces communicate with each other by means of interior diagonal passages crossing in opposite directions. These annular central space D at the inlet end of the piston communicates with the annular surrounding space G at the outlet end of the piston by the diagonal passages *g g g*, while the annular central space E at the outlet end of the piston communicates with the annular space F at the inlet end of the piston, by the diagonal passages *h h h*, as shown in Fig. 1.

In the head A the inner ports, $e\ e^1\ e^2$, &c., communicate through the curved passages with the outer ports, $f\ f^1\ f^2$, &c., and the cylinder-spaces *b* between the wall projections, while the inner corresponding ports, $e\ e^1\ e^2$, &c., of the head B communicate, by similar but oppositely-curved passages and outer ports, $f\ f^1\ f^2$, &c., with the

cylinder-spaces, thereby forming a double-end valve, or a valve having a double capacity in connection with the cylinder-head ports.

The inlet-port A′ always communicates with its corresponding central valve-space, D, and this space always opens some of the inner ports, *e e*^{1} *e*^{2}, &c., of the head A, which allows the water to flow to the left of the piston through the outer ports, while the outlet-port B′ always communicates with its corresponding central valve-space E, and this space always opens communication with some of the inner ports, *e e*^{1} *e*^{2}, &c., of the head B, which allows the water to flow out through the outer ports, *f f*^{1} *f*^{2}, &c., to the right of the piston. At the same time the central valve-space D of the inlet-head opens communication through some of the inner ports of the outlet-head B, through the annular space G, causing the water to flow with the same side of the piston as already has free inlet through the lower piston-space, as just described, while the annular space F at the inlet end of the piston communicates with the central valve-space E at the outlet. By this construction the water entering at A′ is divided, part flowing through the ports *e e*^{1} *e*^{2}, &c., of the head A, and out through the ports *f f*^{1} *f*^{2}, &c., into the cylinder-chamber, and part passing through the diagonal passages *g g g* to the annular space G, and thence through the ports *e e*^{1} *e*^{2}, &c., and *f f*^{1} *f*^{2}, &c., of the head B into the cylinder-chamber. In like manner the water escapes through the ports *f f*^{1} *f*^{2}, &c., and *e e*^{1} *e*^{2}, &c., into the annular space F, and thence through the diagonal passages *h h h* into the central valve-space E to the outlet-port. In a similar manner the water escapes, through the ports *f f*^{1} *f*^{2}, &c., and *e e*^{1} *e*^{2}, &c., of the head B, into the valve-space E to the outlet.

The object of this construction is to give a greater capacity to the valve, and at the same time balance the pressure of the water on each side of the piston, and avoid both friction and wearing, because E and F are outlet-spaces communicating with each other, while D and G are inlet-spaces and communicate with each other.

The piston has a shifting connection with the dial mechanism by means of a central stem, H, as in my said patent, to accommodate the side-rocking movement across the center of the cylinder-chamber.

To obtain a uniform action of the water upon the piston, and prevent the choking of the passages and spaces of the cylinder, deep recesses *i* are formed on the opposite sides of the cylinder-wall projections *a*, to allow free passage between the receiving-spaces of the cylinder on one side of the piston, and free passage of water between the discharging-spaces on the other side of the piston, and
186 thereby cause the pressure of the water in the communicating spaces to be uniform throughout. In connection with these recesses *i* on the sides of the projections, communicating spaces *j* are formed in the walls of the recesses *b* by means of belt projections *k*, Fig. 1, which extend over that side of the projections *b* toward which the piston turns, so as to form bearings for the piston projections *c*, and leave a free passage for the water to follow behind the points *c* of the piston, and thus prevent the retardation of the movements of the piston while a bearing-point, *c*, is leaving a cylinder-recess, and at the same time allow sediment and foreign substances to pass

through the meter without interfering with the proper working of the piston.

Under this new construction of valve, piston, and cylinder-ports I obtain a perfect inlet and outlet valve at each end of the piston, and, in connection with both the inlet and outlet cylinder-ports, giving a uniform action to the piston, and effecting an accurate measurement without loss of pressure in the flow. The water passing into the cylinder-chamber has an inflow and an outflow at each side of the piston as it revolves, and thereby avoids any undue lateral pressure of the water upon the piston. This construction is specially adapted for a valve forming part of the piston, and necessarily controlled by its movements, so as to effect its proper co-operation with the cylinder-head inlet and outlet ports.

I do not confine myself to the specific shape of the piston and the cylinder bearing-points and recesses, as these may be varied and produce the same results; nor do I confine myself to the specific construction of the double-end valve herein described, as the arrangement of the ports and passages may be changed without changing the results or operation.

From the foregoing description it is evident that the valve is complete in itself on each end of the piston, so that either end would form the valve to the exclusion of the other, because the inlet and outlet ports of each end of the piston are independent of each other, with the outlet passing through the piston; and in applying my invention to motors one valve would have sufficient capacity, but for meters the double-ended valved piston is desirable.

I claim—

1. The combination, with the cylinder having the series of inner ports, e to e^6, the outer ports, f to f^6, and a central inlet-port in its head communicating with the cylinder-chamber, of a valve formed within the piston, having inlet and outlet ports at one and the same end, adapted to have a perpetual communication with the central inlet head-port, and a shifting communication with the inner head-ports by the eccentric or side rocking and rotary motions of said piston within and across the center of the cylinder-chamber, in close contact with its heads, for the purpose stated.

2. The valve-ports in the cylinder-heads, and their communicating curved passages, arranged in reverse positions to each other, and combined with the valve of the piston, substantially as described, whereby to cause the inflow of the water to be directed upon opposite sides of a piston having a side-rocking motion across the center of the cylinder, and a revolving motion around its own center, to divide said chamber into receiving and discharging spaces.

3. The piston of a water-meter having a valve formed therein, consisting of the central and annular surrounding spaces at each end, and the communicating diagonal passages, in combination with the inlet and outlet cylinder-ports, and the valve-ports in the cylinder-heads, arranged for operation with a continuous flow of water into and from said cylinder-chamber, and into and from said piston-valve.

4. The belt projections k, arranged upon the walls of the cylinder-

recesses *b*, and between the projections *a*, in combination with the piston bearing-points *c*, adapted for operation with said belt-bearings, to form wall-spaces *j*, to allow the water to follow behind the piston-points, to obtain the advantage stated.

5. The combination, with the cylinder projections *a*, having recesses *i*, of the belt projections *k* in the wall-recesses *b*, whereby to form wall-spaces behind the bearing-points *c* of the piston, and a free passage between the receiving and discharging spaces of the cylinder-chamber, to obtain the advantages stated.

6. The combination, in a water-meter, of a piston adapted to have an eccentric or side rocking and rotary motion within and across the center of the cylinder-chamber, in close contact with its heads, and a valve having both an inlet and an outlet port at each end, with cylinder-heads having inlet and outlet ports communicating with the ports of the valves, whereby the valve at each end operates independent of the other, to maintain a perpetual circulation from inlet to outlet with the ports of both cylinder-heads, and in which there is both an inflow and an outflow into and from each cylinder-head.

In testimony whereof I have hereunto set my hand in the presence of two witnesses.

LEWIS H. NASH.

Witnesses:
F. STUART KING.
S. E. SPEAR.

188 UNITED STATES PATENT OFFICE.

NATIONAL METER COMPANY, of New York, N. Y., assignees of Henry F. Read.

Letters Patent No. 92,884, dated July 20, 1869; Reissue No. 4391, dated May 23, 1871.

Division A.

Improvement in Screw-Propellers for Water-Meters.

The schedule referred to in these letters patent and making part of the same.

Henry F. Read, of Brooklyn, in the county of Kings and State of New York, did invent a new and useful improvement in screw-propellers for liquid meters, which he assigned to the National Meter Company, of New York city, and of which the following is a description:

The nature of the invention consists in constructing a screw-propeller for liquid meters of hard rubber, or other suitable material, by casting the same in suitable metal molds.

In the drawing—

(Here follows diagram marked p. 187.)

Figure 1 represents a vertical section of the caps A A′, embracing the mold, with one of the spiral segments removed in order to expose the interior to view; and

Figure 2, two different views of a spiral segment detached, in order to display its peculiar form.

Figure 3 shows an end view of one of the caps A.

Figure 4 presents a side view, on a double scale, of the mold, with one of the spiral segments G removed, in order to present a better view of its peculiar form.

Figure 5 presents a crose-sectional view of the mold, without the cap, taken through the line *x y*, Fig. 4.

Figure 6 shows a perspective view of screw-propeller when cast.

Figure 7 shows a different construction of the mold, with a part of the cap broken away.

The screw-propeller is preferably cast of soft rubber in metal molds, which soft rubber is then hardened in the mold by heat, or any other suitable process now in use, so that, when the propeller is taken from the mold it is ready for use, with the exception of polishing, &c.

Although it is preferred to make the propeller of rubber, any other substance that can be molded may be used, if such substance is suitable for use in a liquid-meter.

In Figs. 1, 2, 3, 4, 5, and 7 are shown the mold and its parts which are used in the casting, and which form the subject-matter of separate and distinct letters patent bearing even date herewith, but which are hereinafter fully described, to enable others skilled in the art to which this invention appertains to fully understand the same.

In Fig. 4 is shown the body of the mold, with one of the spiral segments G removed. Its interior hollow is uniform in size from one end to the other.

Upon each end is cut a male screw, C C C C. It is composed of several different parts.

The sections from *j* to *j′* and from *i* to *i′* are collars, J and J′, which are made fast to the main body by means of the screws *f*.

Each of these sections is made with a flange, *n*, extending inward from its inner edge, to act as a guide and support to the spiral segments while the screws are being screwed into them. The form of these segments is shown in Figs. 2 and 4. Each one has a female screw in each end. The holes *g* do not extend through, but only a sufficient depth for the insertion of a suitable tool by which to remove the segments when the cast is made.

The spiral slots E′ are formed by cutting away equal portions of adjacent segments, and all are to be as nearly of the same form and capacity as practicable, for these slots are to give form to the wings E of the screw-propeller, shown in Fig. 6.

When these segments are fitted together upon the collars, and the

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H. F. READ.

Improvement in Screw-Propellers for Water-Meters.

No. 4,391. Reissued May 23, 1871.

Fig. 1.

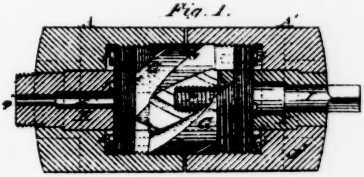


Fig. 3.

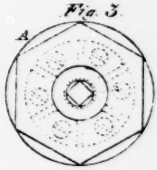


Fig. 2.

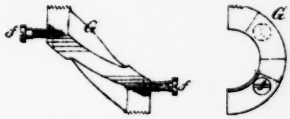


Fig. 4.

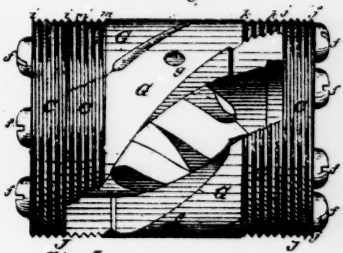


Fig. 6.

Fig. 5.

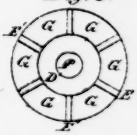
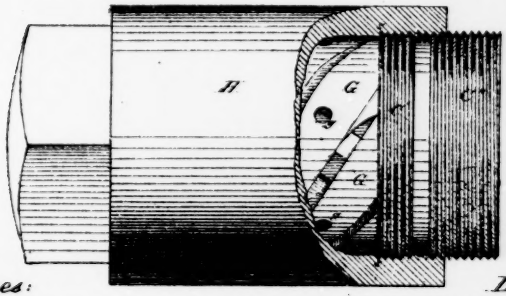


Fig. 7.



Witnesses:
Eugene C. Adams
J. Mitt Wagner

Inventor:
National Water Company
assignee of H. F. Read
By Johnson, Hawkes & Co
their Attorneys

screws *f* are driven home, it is ready for the caps A and A′, and the devices seated in them, respectively.

It will appear from Fig. 1 that the cap A′ is provided, in the interior of its main opening, with a female screw to fit the male thread on the end of the mold, and that above the end of the mold the diameter of the opening is suddenly reduced, and, after continuing at the reduced diameter, it is again reduced, and so continues to the end; and that the plunger K from *j′* upward has a corresponding formation, so that it may be moved downward but not upward; and the part extends into the interior of the molds, and its end is made concave, so as to give the convex form on the large end *r* of the body of the propeller, as shown in Fig. 6; and its interior is recessed to fit the shoulder on the steel mandrel I, so that the mandrel may move downward but not upward when once in position.

The lower end of the mandrel is provided with a male screw-thread, *p*, upon which is formed the female screw *p′* in the large end of the screw-propeller.

When these parts are in position the cap A is screwed upon the upper end of the mold.

The cap A is also provided with a female screw so as to screw over the lower end of the mold, and its plunger is so formed that it will play upward but not downward; and its lower end is formed with a male screw-thread, over which a nut is to be screwed; and the bore in the interior of the plunger has the form indicated by F′ in Fig. 1, to fit over the steel shaft F in Fig. 6; and at the upper end is gradually enlarged, as shown by the dotted lines *d′ d′*, Fig. 1, forming a conical recess to mold the conical portion of the screw-propeller, as shown in Fig. 6.

When the cap A is provided with the described parts, it is screwed upon the lower end of the mold and ready for use.

189 The upper end of the shaft F may be provided with a male screw-thread, so that the shaft may be screwed into the body of the propeller.

The female screw in the large end is made for the reception of a bushing to hold in position an agate or other hard substance, to receive the pivot on which the propeller revolves.

When all the parts are complete the cap A, with its plunger and mandrel, is removed, and a proper quantity of the prepared rubber inserted in the mold through the upper opening, and the cap A′, with its before-mentioned parts, is screwed down over the mold, and in so doing the rubber is forced out into the slots E′ and into the conical portion of the lower plunger, and is cast in the form in Fig. 6. It is then, while in the mold, hardened by any of the processes now in use.

In Fig. 7, where a different construction is shown, the cap H incloses the entire mold.

The spiral segments G G are cut off at S S, corresponding to the line *x y* in Fig. 4; and

C′ represents the female screw in the interior of cap H; while

C″ is a collar with a male screw-thread upon it to fit the female

screw in the cap H, and contains the plunger and steel mandrel contained in the cap A′.

When it is removed the rubber is introduced into the mold, and then the collar C″ is screwed down and the cast is made, after which it is screwed out, and the screw-propeller may be, by the requisite draft on the wings and body, forced out of the mold from below.

The manufacture of both body and wings of screw-propellers of rubber and in one piece, by casting in a mold, is deemed an improvement of great value, since the rubber, when vulcanized, is very light and strong. A propeller made of this material, because of its lightness, will revolve upon the slightest action of the passing fluid, and will thus indicate with the greatest accuracy.

The valcanized rubber, while very strong, is yet slightly elastic, so that if sprung out of form by any extraordinary force it will, when that pressure is removed, resume its original shape without breaking, as cast metal would not do.

It is not acted upon chemically by water, so that it does not render the water impure, and retains its polish, so that it will not become loaded and clogged with dirt and sand, which would increase its weight, roughen its surface, and thus render its indications untrue.

Screw-propellers for meters have heretofore been constructed, generally, of metal, each wing and the body in separate pieces, and the wing soldered upon the body with some soft metal, and are much heavier than those made of rubber, and not, therefore, nearly so sensitive to the action of the fluid, and, of course, are liable to spring out of shape and be torn off by centrifugal force, so that much labor and expense are necessary to keep them repaired and in true form.

What is claimed under this patent as the invention of Henry F. Read is—

1. A screw-propeller for liquid-meters, made in a metallic mold, essentially as described.

2. A screw-propeller for liquid-meters, having its body, spiral vanes or wings E, and interior screw-threads cast at one and the same operation, essentially as described.

3. A hard rubber screwp-ropeller for liquid-meters, as described, as a new article of manufacture.

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JOHN C. KELLEY, *Pres't.*

Witnesses:
EUGENE C. ADAMS.
J. WEST WAGNER.

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Natl Meter Co.
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B'd Water Comrs
} p. 194.

5 Sheets-Sheet 5

F. Ortlieb,

Rotary Steam Engine,

No. 71,208. Patented Nov. 19, 1867.

Fig. 12

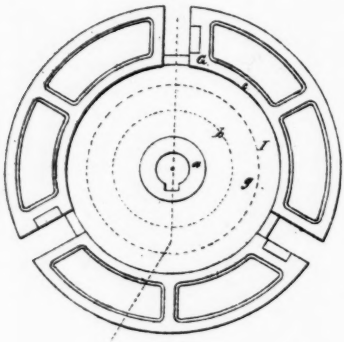


Fig. 13

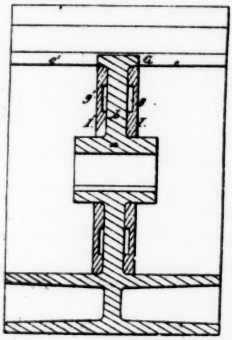


Fig. 14

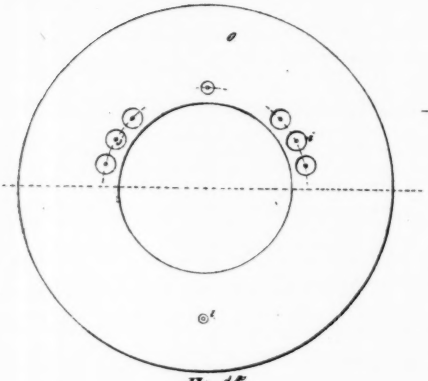


Fig. 16

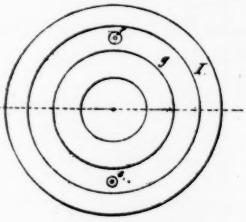


Fig. 17

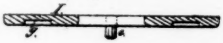


Fig. 15

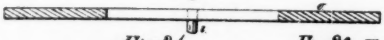


Fig. 19

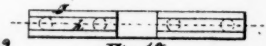


Fig. 21

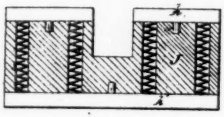


Fig. 20

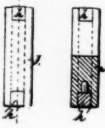
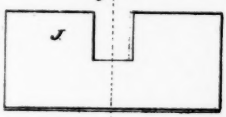


Fig. 22

Fig. 18



Witnesses:
J. W. Connelly
A. Lecleny

Inventor
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5 Sheets-Sheet 4

F. Ortlieb,

Rotary Steam Engine.

No. 71,208. Patented Nov. 19, 1867.

Fig. 10.

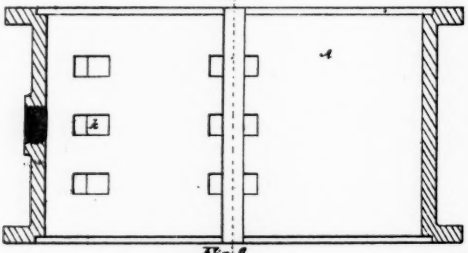

Fig. 9.

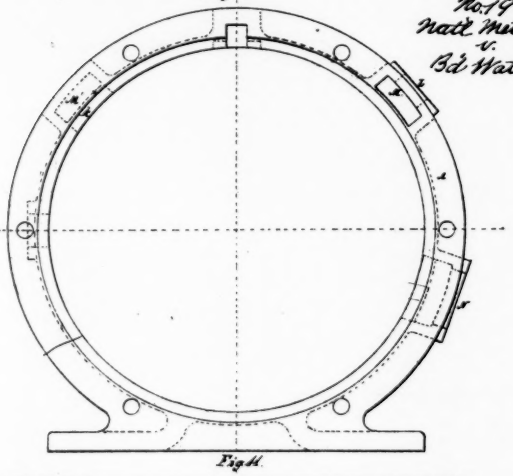

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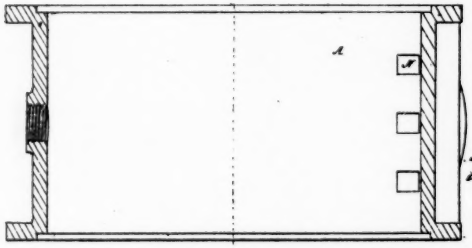
Fig. 11.



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Rotary Steam Engine.

No. 71,208. Patented Nov. 19, 1867.

Fig. 7.

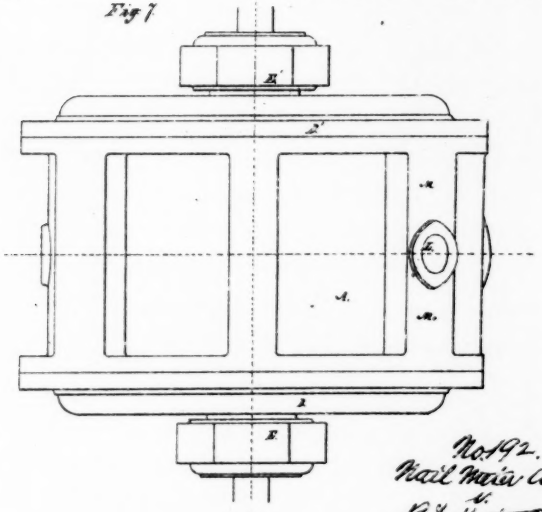

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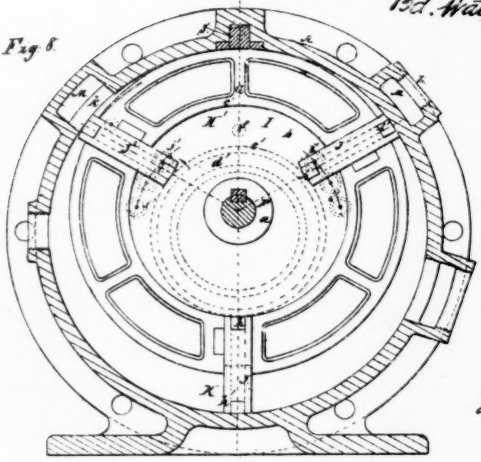
Fig. 8.



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5 Sheets-Sheet 2.

F. Ortlieb,

Rotary Steam Engine.

No. 71,208. Patented Nov. 19, 1867.

Fig. 4

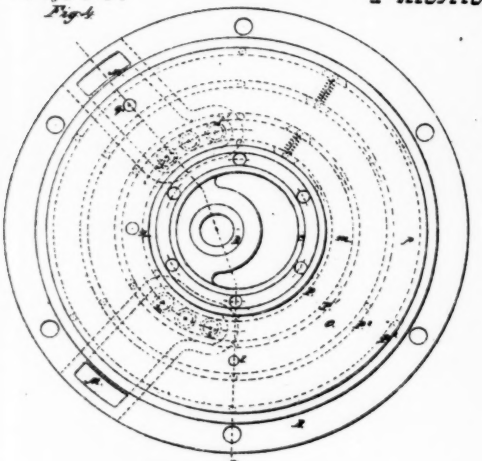


Fig. 6

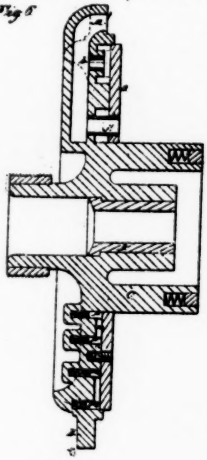


Fig. 3.

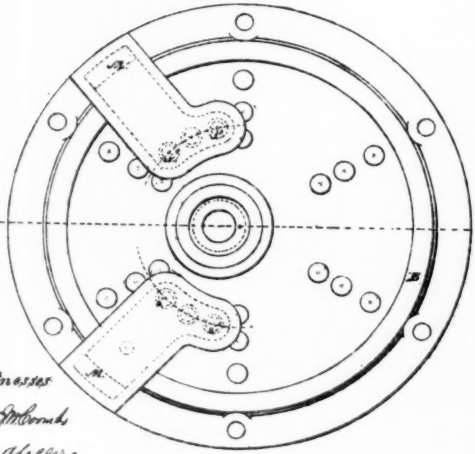
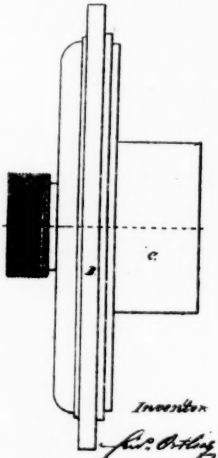


Fig. 5.



Witnesses
J. M. Coombs
A. Kellerg

Inventor
Fr. Ortlieb

No. 192
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v.
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} p. 190

5 Sheets-Sheet 1.

F. Ortlieb,

Rotary Steam Engine.

No. 71,208. Patented Nov. 19, 1867.

Fig. 1.

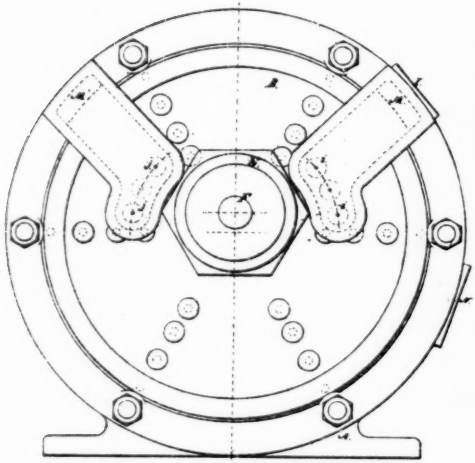
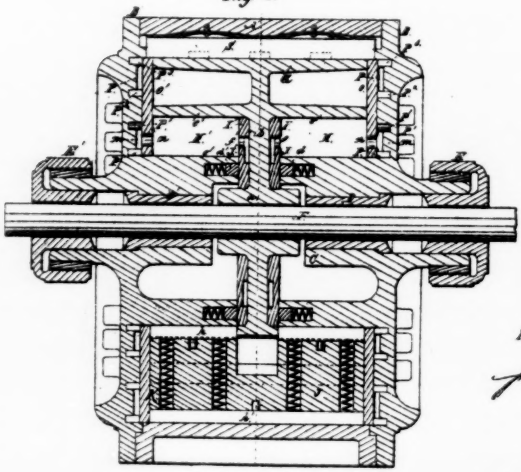


Fig. 2.



Inventor
[signature]
A. Lecerq

Inventor
[signature]

195 UNITED STATES PATENT OFFICE.

FREDERICK ORTLIEB, of Williamsburg, New York, assignor to the Metropolitan Rotary Engine Company, of New York.

Letters Patent No. 71,208, dated November 19, 1867.

Improvement in Rotary Engines.

The schedule referred to in these letters patent and making part of the same.

To all whom it may concern:

Be it known that I, Frederick Ortlieb, of Williamsburg, Brooklyn, in the county of Kings, and State of New York, have invented a new and useful improvement in rotary engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings forming part of this specification, and in which—

(Here follow diagrams marked pp. 190, 191, 192, 193, & 194.)

Figure 1 represents a front or side view of a rotary engine, constructed according to my invention.

Figure 2, a transverse section of the same, taken as denoted by the line *x x* in Fig. 1.

Figure 3, an exterior face view of one of the cylinder-covers.

Figure 4, an interior face view of the same.

Figure 5, an edge view thereof, and

Figure 6 a section through the line *y y*, in Fig. 4.

Figure 7 represents a plan view of the engine, and

Figure 8 a section of the same, at right angles to Fig. 2.

Figure 9 is a side view of the engine-cylinder, with the covers removed, and

Figures 10 and 11 transverse sections thereof, the one showing the upper and the other the lower halves or portions thereof.

Figure 12 represents a face view of the engine-piston or revolving cylinder, with its radial arms or slides removed.

Figure 13, a transverse section thereof, with its balance-plates.

Figure 14, a face view of one of the large balance-plates which fit within the ends of the cylinder.

Figure 15 a transverse section of the same, and

Figures 16 and 17 similar views of one of the small balance-plates connected with the piston.

Figures 18, 19, 20, 21, and 22 are side, edge, end views, and longitudinal and transverse sections of one of the radial slides carried by the piston or revolving cylinder.

Similar letters of reference indicate corresponding parts throughout the several figures.

My improvement has reference to that class of rotary engines which employ a revolving piston, made up of or carrying radial slides, and, together with the driving-shaft to which it is secured

occupying an eccentric position relatively to the engine cylinder; and my invention consists, firstly, in a novel construction or combination of parts, involving or constituting a new mode of applying or using the steam, first at a high pressure on a short piston leverage, and afterwards expansively at a lower pressure on a longer piston leverage, in such manner as to counteract lateral thrust or strain on the piston or engine-shaft by pressure of the steam on the periphery of the piston or rotating cylinder carrying the radial slides. Said invention also consists in a combination of parts and disposition of ports for thus using the steam, whereby the piston itself, or radial slides thereof, serve, without the aid of valves, to control not only the inlet and exhaust or final escape of the steam, but also its passage after being utilized in a high-pressure form to work expansively in a separate cylinder or chamber upon or in connection with one and the same piston. And said invention further consists in a combination of steam-balance plates and packing-rings, in connection with ports controlled by the radial slides for keeping steam-tight, with but little or no friction, the edges of the latter and ends of the rotating piston or cylinder carrying the slides. Furthermore, the invention consists in such a disposition of inner and outer cylinders or chambers and piston with its slides working therein relatively to the exhaust, as that, in condensing the expanded steam, the cooling effect thereby produced will be confined to a limited portion only of the outer cylinder or case, without subjecting the inner or high-pressure cylinder thereto.

Referring to the accompanying drawing, A represents an outer cylinder or case, and B B′ its lids or covers, which are constructed to project internally at their centres, as by cylindrical formations C C′, that are bored or formed with tubular passages through them and their lids or covers in directions which are eccentric to but parallel with the axis of the cylinder A, for reception of bushes D D′, and stuffing-boxes or glands E E′, within and through which the rotating, driving, or piston-shaft F works. The piston or re-
196 volving cylinder, G, carrying the radial slides, is made up of a hub, *a*, by which it is secured to the shaft F, centrally dividing-disk or plate *b*, and inner ring or periphery *c c′*, forming, in connection with the cylindrical formations C C′, interior steam-spaces, chambers, or cylinders H H′. The ends of the cylindrical formations C C′ are furnished with spring-borne packing-rings *d d′*, which bear or press against steam-balance plates or disks I I′, arranged to face or lie against and cover either side of the dividing-disk *b*, between the hub *a* and inner ring or periphery *c c′* of the piston. These balance-plates I I′ are geared with the dividing-disk *b* by steady-pins, *e*, so as to rotate with the piston, but otherwise are loose or free to play longitudinally in relation to the shaft F, being in a manner balanced, as it were, and pressed outwards by steam entering from and of the same pressure as in the cylinders H H′, through apertures *f f′*, communicating with cavities *g g* in the backs of said plates, to pack in a steam-tight but free manner the inner edges of the radial slides J J¹ J², for the lower portion of their lengths within the cylinders or chambers H H′, in their radial and rotary

actions, and serving, in connection with the packing-rings *d d'*, to prevent leakage generally past the lower ends or portion of the piston, carrying the independent slides J J^1 J^2 in the chambers H H', on opposite sides of the dividing-disk *b*. These slides, consisting, as here shown, of three, disposed at an equal distance apart, are or may be fitted with the usual end-packings *h h'*, forced out by springs, and are made to slide freely through recesses in the revolving piston or cylinder G, the eccentric position of which, relatively to the stationary cylinder A, forms between the outer periphery of said revolving cylinder and inner periphery of the stationary one a steam-cylinder, space, or chamber, K, within which the radial slides J J^1 J^2 also play, and in which the steam, after it has done duty at a high pressure in the cylinders or chambers H H', is made to work expansively to impel or rotate the piston. This I effect in a peculiar manner, and without the aid of valves or complicated gear for cutting off the influx of high-pressure steam to the inner cylinder or cylinders, and regulating its passage to the outer cylinder, and after having performed its duty there, discharge from the same to the condenser or otherwise, and so that the high-pressure steam which acts upon the short leverage of the piston is aided by an equal force, or thereabouts, on the longer leverage by the expanded steam and lateral pressure thrown upon the shaft F by the high-pressure steam acting on the inner periphery *c c'* of the piston is counteracted by the expanded or low-pressure steam in the cylinder K in its action on the outer periphery of the piston or revolving cylinder G, the areas or proportions of the cylinders H H' and K being suitably regulated for such purpose, as is also the timely supply of high and low-pressure steam to act simultaneously in opposite radial directions, as described, upon the revolving piston or cylinder G. Thus, for instance, high-pressure steam is introduced by an inlet, L, branch ways or passages M, and tubular passages *i i*, into the cylinders or chambers H H'. The live steam, thus admitted, acts upon one of the radial slides on both sides of the piston-dividing disk, and causes the piston to move asound or continues its pressure on the lower portion of said slide, till, in the rotation of the piston, tubular passages *j j'* are uncovered in the rear of said slide by the passage of the latter over them, for escape of such high-pressure steam into ways M', from whence it enters by a port or ports, *k*, into the outer steam-chamber K, where it is caused to act expansively on the longer leverage of the piston or radial slide exposed to it. The position of one of the three piston-slides is such as always to receive the impulse of the live steam passing from the inner cylinder, which continues to work expansively until it is allowed to escape into the atmosphere or condenser through a final exhaust-port or ports, N.

From this description, and by reference to the annexed drawings, it will be seen that the high-pressure steam acts on a short lever, while the expanded steam acts on a proportionately longer lever; also, that a counteracting pressure is induced upon the inner and outer peripheries of the revolving piston or cylinder G, which obviates or reduces lateral strain or pressure on the engine-shaft F. And it will further be seen, that by the disposition of the high and

low-pressure cylinders, open to the action of a common piston, and arrangement of the ports or passages, the condenser (where the engine is a condensing one) can never affect or exercise a detrimental cooling effect upon the high-pressure cylinder, nor yet, where a triplicate arrangement of radial slides is used, upon more than one-third or thereabouts of the outer cylinder.

As before observed, it will likewise be seen that although the engine is a perfect high-pressure and expanding condensing engine, the usual steam and cut-off valves used in other engines are entirely dispensed with, the radial slides performing the alternate duties of pistons, steam and cut-off valves without the interposition of further mechanism.

In addition to the small balance-plates I I′ to the interior edges of the divided piston, there are also larger and outer steam-balance plates O O′, fitted partially into each cylinder-head or cover B B′, and made to enter the ends of the cylinder A, to form a steam-tight joint to the outer edges of the piston. Behind each of these balance-plates O O′, which serve to pack the radial slides throughout their entire lengths, are packing-rings P P^1 and P^2 P^3, fitted steam-tight into each cylinder-head or cover in such manner as to allow motion only in the direction of or towards the balance-plates, which, as well as the packing-rings, are prevented from rotating by steady-pins *l*. Between the two inside packing-rings P P^1, on either side of the engine, there is a recess, *m*, the area of which corresponds to the exposed side area of the chamber H or H′, and from which chamber or chambers high-pressure steam is admitted by a passage or passages, *n*. A similar recess, *p*, is also formed between the outer packing-rings P^2 P^3, the area of which corresponds to the exposed side area of the chamber K, from which latter to the recess P, low-pressure or expanded steam is admitted by a passage or passages, *q*.

The object of the steam-balance plates is to form a steam-tight joint against the piston at all times and under all pressures, without increase of friction, and without having recourse to a heavy spring-pressure to make tight the packing; in fact, a perfect balance can by these means be established, and the friction reduced to a mere nominal degree, only light springs, if necessary, being inserted to act upon the back of the balance-plates O O′. The object of the steam-tight packing-rings circumscribing the recesses *m p* is to prevent the high-pressure steam from escaping from its allotted chamber or recess into that of the low-pressure or expanded steam.

197 The packings *h h′* in the radial slides may be forced out by intermediate springs, and an upper spring-borne packing, S, be provided the stationary cylinder A at its top, to make tight the outer periphery of the piston or cylinder G in the upper portion of its travel, all as represented in the accompanying drawings.

What I here claim, and desire to secure by letters patent, is—

1. The combination, with a rotating piston made up of radial slides, and occupying an eccentric position relatively to the outer case, of separate inner and outer steam-cylinders or chambers, when the one of said cylinders serves to use the steam expansively from the other in such manner as that the radial slides which form a pis-

ton or pistons common to both, are acted upon by high-pressure steam at a short leverage, and by the expanded steam at a longer leverage, and lateral pressure on the main shaft, reduced or counteracted by the live or high-pressure and expanded steam conjointly, substantially as specified.

2. The arrangement, relatively to the inner and outer steam-cylinders or chambers and rotating piston common to both, of the several inlets and outlets for, without extra mechanism, and by the action of the radial slides composing the piston, the admission of high-pressure steam to the inner cylinder or cylinders and passage therefrom, after performance of its duty, to the outer cylinder or chamber, to work expansively in the latter on said piston, and in due course discharge therefrom, essentially as herein set forth.

3. The arrangement, substantially as herein described, of the revolving piston, with its radial slides, inner and outer steam-cylinders, and exhaust-port in the outer cylinder to the condenser, for preventing the high-pressure cylinder and greater portion of the low-pressure one from being cooled by the condenser, essentially as specified.

4. The steam-balance plates I and O, or I′ O′, the one of them (O or O′) being stationary and connected with the outer cylinder, and the other (I or I′) rotating with the piston, and both serving to pack the edges of the radial slides and to relieve the piston of friction, essentially as herein set forth.

5. In combination with the steam-balance plates O O′, the packing-rings P P^1 P^2 P^3, and recesses *m p*, communicating with the high and low-pressure cylinders of the engine, substantially as described.

FRED. ORTLIEB.

Witnesses:
HENRY T. BROWN.
J. W. COOMBS.
A. LE CLERC.

199 UNITED STATES PATENT OFFICE.

EDWIN CHAPMAN, of Rochester, Minnesota.

Letters Patent No. 70,802, dated November 12, 1867.

Improvement in Rotary Engines.

The schedule referred to in these letters patent and making part of the same.

To all whom it may concern:

Be it known that I, Edwin Chapman, of Rochester, in the county of Olmsted, and State of Minnesota, have invented a new and useful improvement in rotary steam engines; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable those skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

(Here follows diagram marked p. 198.)

This invention relates to certain useful improvements in the class of steam engines known as rotary engines, and it consists principally in the manner in which the abutments are operated, and in the manner in which the steam is discharged into the cylinder and exhausted therefrom.

Figure 1 is a vertical section of the engine, through the line *x x* of Fig. 3.

Figure 2 is a vertical section of Fig. 1, through the line *y y*.

Figure 3 is a top or plan view of the engine.

Figure 4 is a section through the line *z z* of Fig. 1.

Similar letters of reference indicate corresponding parts.

This engine is attached to a frame, which sets on and is secured to a bed-plate. A represents the bed-plate. B is the frame, which is raised above the bed-plate, and rests on pillars *a*. C is the cylinder, which is formed of two parts or half cylinders, in which works the piston D. E is the engine shaft. F is the steam pipe, which is connected with the boiler. The steam enters the cylinder through the face of the piston at *c*, as seen in Fig 2. The piston is attached to a disk-plate, *d*, which is securely fastened to the shaft E, and is connected with the steam pipe F by a chamber which is made in the eye of the cylinder marked *e*. *f*, Fig. 1, is an aperture from the cylinder to the centre of the shaft, which shaft is made hollow, as seen in Fig. 2, for the exhaust of the steam. The chamber *e* is always under a pressure of steam, with an aperture, *g*, connecting it with the piston, so that whenever the piston passes the aperture *g*, the piston takes steam, or rather discharges steam through the aperture *c* against the abutments *h h*. The cylinder is slotted on each side, as seen in fig. 1, so that these abutments can play in and out. These abutments are attached to vertical shafts *i i*, which shafts are supported by wings J J, which project from each side of the cylin-

E. Chapman,

Rotary Steam Engine.

No. 70,802. Patented Nov. 12, 1867.

Nat'l Water Co. No. 192 } p. 198.
Bd. Water Comrs

Fig. 1.

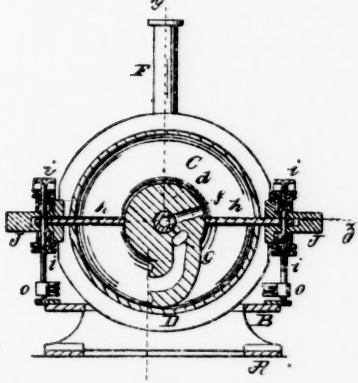


Fig. 2.

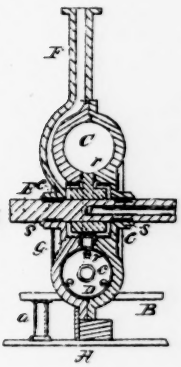


Fig. 3.

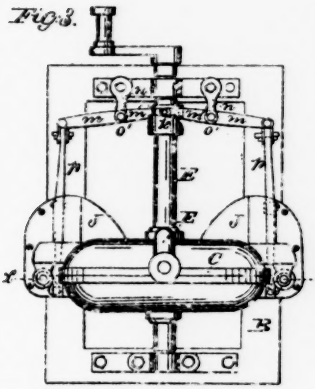
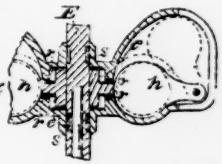


Fig. 4.



Witnesses:
Theo. Inoche.
J. H. Service.

Inventor:
E. Chapman
Per Munn & Co.
Atty's

199 UNITED STATES PATENT OFFICE.

EDWIN CHAPMAN, of Rochester, Minnesota.

Letters Patent No. 70,802, dated November 12, 1867.

Improvement in Rotary Engines.

The schedule referred to in these letters patent and making part of the same.

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E. Chapman,

Rotary Steam Engine.

No. 70,802. Patented Nov. 12, 1867.

No. 192
Natl Meter Co.
v.
Bd. Water Comrs } p. 198.

Fig. 1.

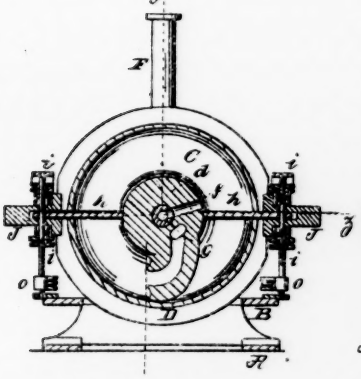


Fig. 2.

Fig. 3.

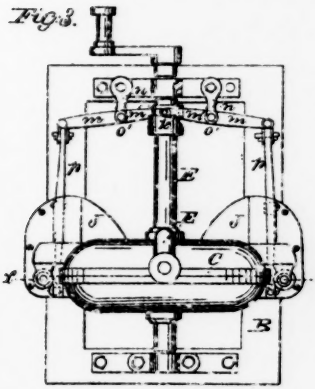
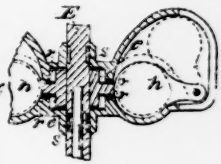


Fig. 4.



Witnesses:
Theo. Inoche.
J. A. Service.

Inventor:
E. Chapman
Per Munn & Co.
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der. These wings are formed of two plates, each having recesses between them, into which the abutments are thrown when they are turned from the cylinder. The shafts *i* are packed by stuffing-boxes, *i'*, on each side of the wings, as seen in the drawing.

The manner in which these abutments are operated, so that they shall receive the full pressure of steam, and recede from the cylinder to allow the piston to pass at every revolution, is as follows: In the shaft at *k* there is an eccentric groove. *m m* and *m' m'* are arms, which are attached to vertical shafts *o'*. *n n* are brackets, by which the top ends of the shafts *o'* are supported. There are pins on the ends of the arms *m'* which work in the eccentric groove *k*, so that as the shaft revolves the upright shafts *o'* are partially revolved or given a vibratory motion. To communicate this vibrating motion to the shafts *i*, and thus operate the abutments *h*, there are other arms on the shafts *o'* marked *m*. *p p* are rods, which connect the arms *m* with the shafts *i* by short cranks or arms *o*. The motion thus imparted to the abutments is sufficient to throw them entirely from the cylinder, as well as into it, at every revolution of the shaft E. Outside of the chamber there are small packing-rings, seen at *r*. These rings are tapering or wedge-shaped, and are cut like ordinary packing-rings in one or more places. As the surfaces wear, the spring of the ring, in its tapering seat, will force it out so that it will always insure a tight joint. Around the shaft E there are also packing-rings, S S, which are cut in one place, and spring into a recess, as seen in the drawing, for the purpose of insuring a tight joint between the shaft and the central portion or eye of the cylinder. The aperture *f* in the revolving disk-plate of the piston, being brought in communication with the hollow shaft twice in each revolution, the steam is exhausted thereby from the end of the shaft E.

Having thus described my invention, what I claim as new, and desire to secure by letters patent, is—

1. The arrangement of the steam-chamber *e*, aperture *g*, and packing *r*, with reference to the piston D and shaft E, as herein described, for the purpose specified.

2. The construction of the piston D, provided with the opening for discharging steam into the cylinder, and opening *f*, for exhausting the steam through the shaft, substantially as herein shown and described.

The above specification of my invention signed by me this 28th day of May, 1867.

EDWIN CHAPMAN.

Witnesses:

WM. F. McNAMARA.

ALEX. F. ROBERTS.

203 UNITED STATES PATENT OFFICE.

LEWIS HALLOCK NASH, of Brooklyn, assignor to the National Meter Company, of New York, N. Y.

Water-Meter with Revolving Piston.

Specification forming part of Letters Patent No. 336,143, dated February 16, 1886; application filed October 19, 1885; serial No. 180,322. (No model.)

To all whom it may concern:

Be it known that I, Lewis Hallock Nash, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented new and useful improvements in water-meters, of which the following is a specification.

My improvement herein is directed to the type of water-meter patented to me January 28, 1879, numbered 211,769, in which a valve-forming piston has alternate projections and recesses which continually change their points of bearing with corresponding bearing points and recesses on the inner wall of the inclosing-case, in a manner to cause said piston to have an eccentric movement within the case and every projection of the piston to describe an orbit similar to that described by the center of the piston, which is the path of a circle around the center of the case. Such construction and operation effects the division of the case-chamber at two or more points into receiving and discharging spaces, which continually change their volume, with an unobstructed flow and a positive displacement of the water through the piston-ports from the discharging-spaces of the case-chamber by the revolution of the piston from one bearing-point to another across such chamber.

In my said patent the valve-forming piston has one less number of projections than the case-chamber, while in my present improvement the dividing bearing projections are of equal number in both the piston and the case-chamber, which involves a motion of the piston slightly different from that described in my said patent. Such construction of equal number of coacting joint-forming projections I do not claim, broadly, as both water-meters and steam-engines have been used having such construction, and my improvement in such construction is directed to a more effective and accurate operation of the meter, and to avoid unequal pressure within chambers which are all filling or all emptying by providing free communication between those chambers which are discharging and those which are filling.

To this end my improvement consists of a novel construction of the joint-forming projections of the piston and of the case, whereby, in a water-meter having equal number of such projections on the piston and on the case, the latter will be divided at opposite points, leaving the measuring-chambers on both sides of such division in free communication, and thereby equalize the pressures in all the

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(No Model.) 3 Sheets—Sheet 3.

L. H. NASH.

WATER METER WITH REVOLVING PISTON.

No. 336,143. Patented Feb. 16, 1886.

Fig. 5.

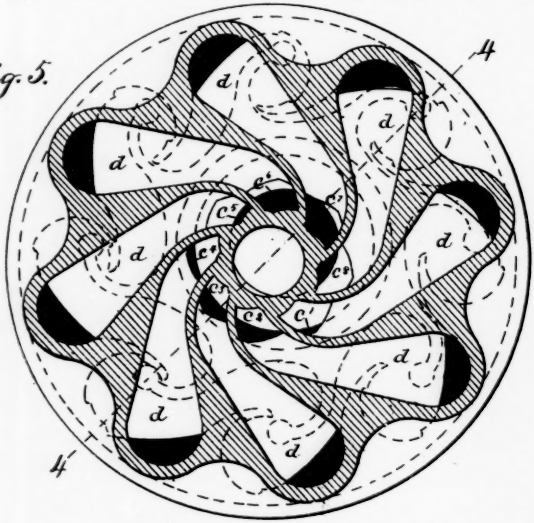
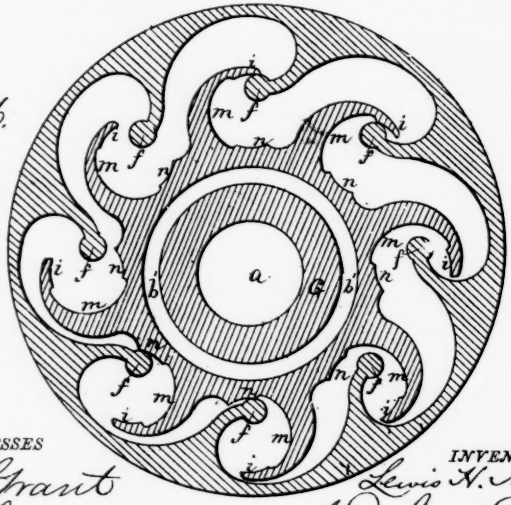


Fig. 6.



WITNESSES
R. F. Grant
W. E. Stearns

INVENTOR
Lewis H. Nash
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Attorneys.

No 192
Natl Meter Co.
vs
Bd Water Comm } p. 201.

(No Model.) 3 Sheets—Sheet 2.

L. H. NASH.

WATER METER WITH REVOLVING PISTON.

No. 336,143. Patented Feb. 16, 1886.

Fig. 3.

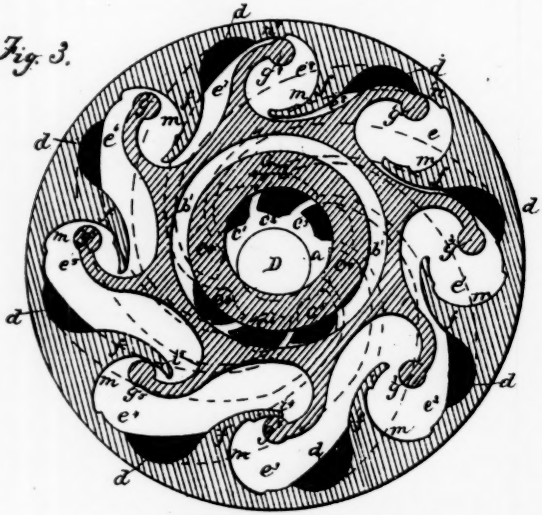
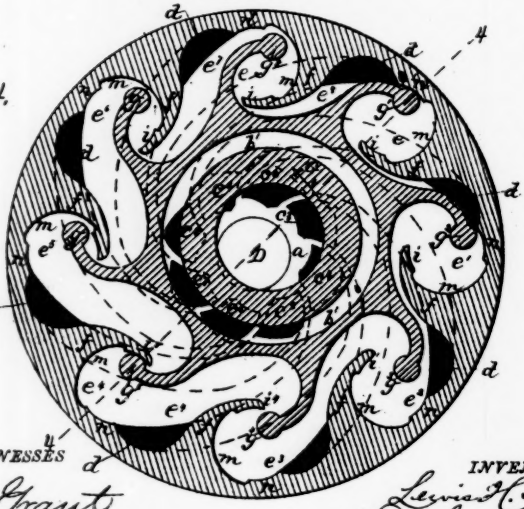


Fig. 4.



WITNESSES

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No. 192
Natl Meter Co.
Bd Water Comm } p. 200.

(No Model.) 3 Sheets—Sheet 1.

L. H. NASH.

WATER METER WITH REVOLVING PISTON.

No. 336,143. Patented Feb. 16, 1886.

Fig. 1.

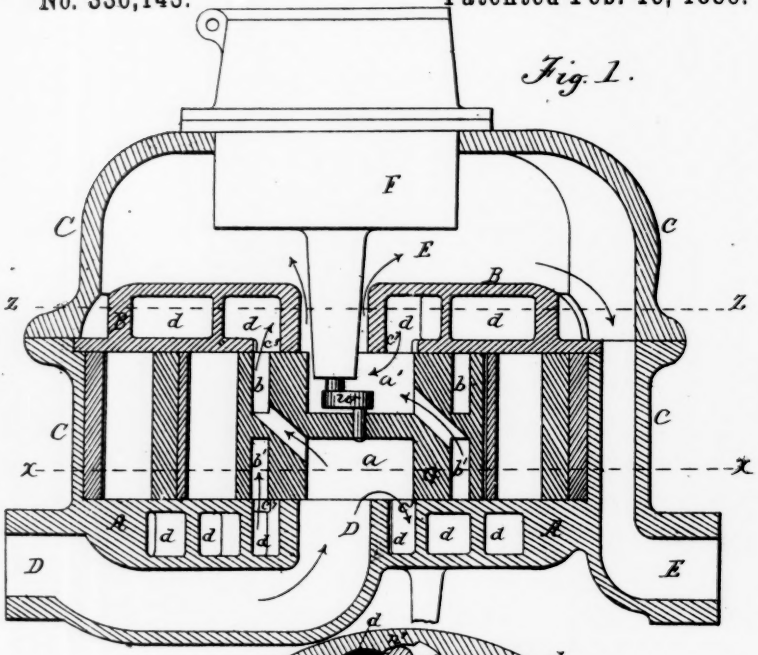
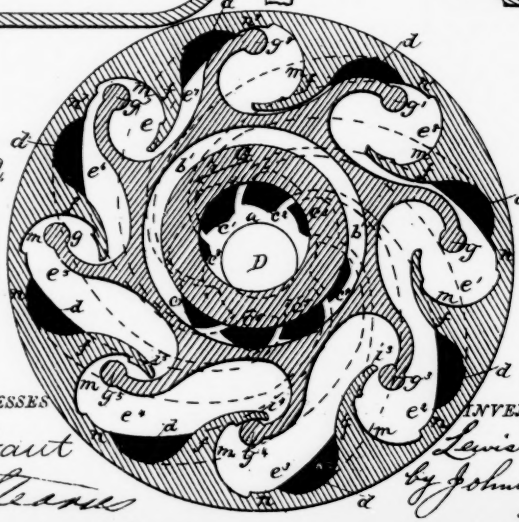


Fig. 2.



WITNESSES
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Attorneys.

measuring-chambers. This, so far as I know and can find, has never been proposed in a meter having an equal number of projections on its piston and case, and in the accompanying drawings I have illustrated such improvements, and in which—

(Here follow diagrams marked pp. 200, 201, & 202.)

Figure 1 represents a vertical section of my meter, taken on the line 4 4 of Fig. 4; and Figs. 2, 3, and 4 are horizontal sections taken on the line *x x* of Fig. 1, showing different positions of the piston. Fig. 5 represents a horizontal section taken on the line *z z* of Fig. 1; and Fig. 6 represents a modification, showing a slightly-different construction of the joint-forming projections.

The construction and operation of the meter, except in the particulars of the improvements indicated, are substantially the same as in my patent aforesaid.

The piston operates between heads which have an arrangement of inlet and discharge ports, the lower head, A, and the upper head, B, having an arrangement of like ports, which operate in connection with the valved piston. A case, C, incloses these parts and forms the inlet-passage D and the outlet-passage E, within which latter the box F, containing the registering mechanism, depends. The cylinder-heads have central openings, which have perpetual communication with the inlet and outlet passages and the ports *a a'* in the opposite ends of the piston, and which chamber-ports form the inlet and the outlet ports of the piston-valve. The piston G is constructed with interior-ports, *b b'*, the port *b* opening at the top end of the piston and into its lower central port, *a*, and the port *b'* opening at the bottom of the piston and communicating with its top central port, *a'*, and these ports *b b'* are annular. These piston-ports *b b'* are so arranged as to operate with the ports in the heads to admit and discharge the water. The lower head-ports, *c c' c² c³*, &c., are placed around the center of the lower head in such relation
204 to the annular piston-ports *a* and *b'* as to be alternately opened and closed by the movement of the piston, and these ports *c c'*, &c., extend by curved passages *d* to and open into the chamber measuring-spaces *c' c² c³ c⁴ c⁵ c⁶ c⁷ c⁸*. The arrangement of the ports in the upper head is the reverse of that in the lower head—that is, their communicating passages curve in opposite directions, and they act in the same manner to open and close the chamber measuring-spaces by the movement of the piston. These head-ports are shown in Fig. 1 and in the horizontal sectional views by dotted lines, and in which Fig. 5 also shows their reverse relation in the top head in full lines. The interior wall of the measuring-chamber is formed with alternate projections *f*, which extend from head to head, and are preferably of the curved form shown, and are of a length sufficient to form a joint with similar projections of the piston at certain points only. The piston projections *g* are preferably curved opposite to that of the case projections, and are formed with bearing ends, which make contact at the points *i* and *n* of the case projections, one of which contact-points, *n*, is at the ends of said case projections, and the other, *i*, upon the wall of the case, leaving be-

tween these points recess-spaces m, which provide for free communication between adjacent chambers, while the piston projection is passing over these recess-spaces m, as will be more fully stated in the description of the operation of the meter.

I prefer to make the projections upon the case-wall and upon the piston of the curved form shown, for simplicity of construction, and because the piston only needs to make contact with the case at the two opposite sides of the case.

In Fig. 6 the two bearing-points are upon the piston, but the action is the same as having them upon the case; nor is it necessary that these projections should have the particular form shown, so long as they operate to form the bearing-joints, as stated.

Now, referring to Figs. 4 and 5, the piston is in position to form the division of the case-chamber at the bearing-points g' and n' and g^5 and i^5, the intermediate spaces between these bearing-points on each side of the piston having free communication. The water enters from the passage D into piston-ports a and b, and passes thence through the lower head-ports, c', c^2, c^3, and c^4, thence through their curved passages d into the case-chambers e' e^2 e^3 e^4 on the inlet side of the piston. From the piston-port b the water enters from the upper head into the ports c' c^2 c^3 c^4, passing thence through their curved passages d to the same case-chambers on the inlet side of the piston, driving the piston in the direction of the arrow, and forcing out the water from the case chambers e^5 e^6 e^7 e^8 through the curved passages d and the head-ports c^5 c^6 c^7 c^8 into the piston-ports b' and a', and thence through the passage E. In this way the piston is moved to the position Fig. 3. In this figure the contact-points g' and n' and g^5 and i^5 are on the point of breaking contact, and the points g^8 and n^8 and g^7 and n^4 are just making contact; hence the chambers e^8 and e^4 are closed, and the valve-ports c^4 c^8, connecting with these chambers, are closed. In this position of the piston the water enters through the ports c' c^2 c^3, and discharges through the ports c^5 c^6 c^7, driving the piston in the direction of the arrow 1 to the position Fig. 2. In this figure the contact-points are made at g^8 n^8 and g^4 and i^4, and the head-ports c^8 are just open to the inlet and the port c^4 just open to the outlet, so that the water now enters the ports c^8 c' c^2 c^3, and escapes through the ports c^4 c^5 c^6 c^7, driving the piston in the direction of the arrow 1 until the contact-points g^7 n^7 and g^3 and i^3 are brought into contact, when the ports c^3 c^7 are closed, and the motion of the piston continued in a similar manner as described in relation to Fig. 4. In this way the piston operates to alternately open and close its ports as its points of bearing upon the case projections change.

Referring to Fig. 4, as illustrating the manner in which free communication is made between adjacent measuring-spaces, it will be seen that there is free communication between the spaces e' e^2 e^3 e^4, since the piston and case do not form contact at any point between these spaces, and therefore if there be any difference in the pressures in these spaces it will be instantly equalized. The same thing is true of the outlet-spaces e^5 e^6 e^7 e^8, and therefore there cannot be

unequal pressure nor dead-spaces in the case-chambers or any of them during the operation of the meter.

In my said patent the valved piston and the case-chamber are constructed with co-operating joint-forming projections of unequal number, and the piston operates to control both the inlet and the exhaust, while my present improvement effects the same operation with equal number of projections, in which the valved piston has a new motion, which is necessary to control both the inlet and the exhaust.

The communication between the adjacent chambers on each side of the bearing-points is made by forming the points of the projections so that they do not make intermediate contact, because the walls of the piston projections are made so as not to touch the ends of the case projections between these spaces when in communication.

The registering mechanism is controlled by the movement of the piston by means of the crank-connection w. (Shown in Fig. 1.)

The form and relation of the bearing projections are determined by the following considerations: Referring to Fig. 3, the measuring-space e^4 is shown as just on the point of changing from a receiving to a discharging space, and the points g^4 i^4 having just come in contact and the points g^5 i^5 just about to break contact. At this instant the supply-port c^4 has been closed by the inlet-port a and is about to be opened by the outlet-port b'; hence all communication is closed with chamber e^4. Now, if this chamber were rapidly decreasing in size, the water contained therein would be crowded before there was sufficient escape for the water and retard the movement of the piston; but if this chamber changes from a receiving to a discharging chamber at a time when it is not changing in volume, the piston will be free to move, so as to open the discharge-ports without crowding the water in said chamber. It is for this reason that the case and piston projections are so formed as to lap, so that the bearing-points will come in contact when the piston has a motion at right angles to the line joining the points of contact, and hence making no crowding of the water.

I claim—

1. The combination, in a water-meter, of a revolving non-rotating piston having circumferential projecting points and inlet and discharge ports concentric with each other, with a case having an equal number of joint-forming points and head-ports operated by the concentric inlet and outlet valve-ports of the piston, substantially as described, for the purpose specified.

2. In a water-meter, the piston and its inclosing-case chamber, both having an equal number of coacting projections adapted to divide said chamber into receiving and discharging measuring-chambers, the combination of such piston having bearing-points with the case projections having wall-recess spaces m, whereby to provide for free communication and equal pressure between adjacent measuring-chambers at the inlet and outlet sides of said piston, substantially as described.

3. The combination, in a water-meter, of a revolving non-rotating piston having projecting bearing-points and inlet and outlet ports concentric with each other, with a case having an equal number of joint-forming bearing-points having recesses *m* in the vertical walls on one side of each projection, and case head-ports c' c^2, and operated by said concentric valve-ports, substantially as described, for the purpose specified.

4. In a water meter, the case and the piston, each having an equal number of joint-forming bearing-points dividing the case-chamber into receiving and discharging measuring-spaces, the wall-recess spaces *m*, connecting the said measuring-spaces, in the manner and for the purpose stated.

5. In a water-meter, the piston having projecting bearing-points and concentric ports, in combination with a case having an equal number of projecting bearing-points, the said bearing-points of the piston and case curved in opposite directions and lapping in the operation of the meter by a movement upon each other without crowding the water in the space which they close, whereby to avoid retarding the movement of the piston, as herein set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

LEWIS HALLOCK NASH.

Witnesses:

A. E. H. JOHNSON.

J. W. HAMILTON JOHNSON.

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Bd Water Comrs } p 208.

3 Sheets—Sheet 3.

B. FITTS.

WATER-METER.

No. 178,829. Patented June 13, 1876.

Fig. 8.

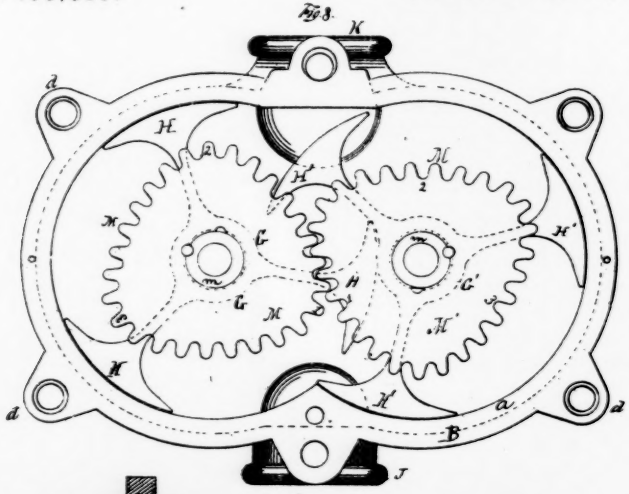
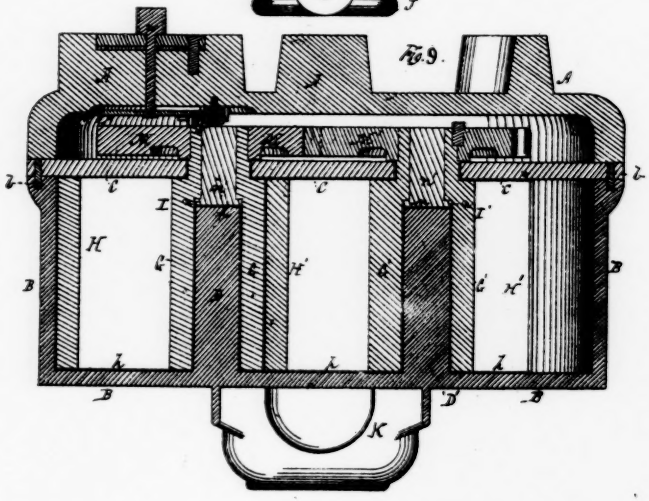


Fig. 9.



Witnesses.
L. Van Reswick
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atty.

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Natl Meter Co.
v.
Bd Water Comrs } p. 207.

3 Sheets—Sheet 2.

B. FITTS.

WATER-METER.

No. 178,829.

Patented June 13, 1876.

Fig. 10.

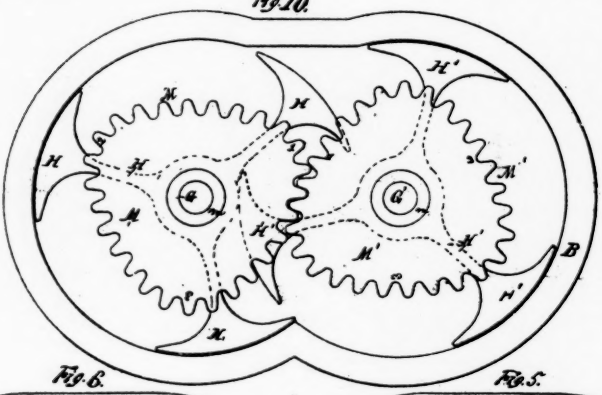


Fig. 6.

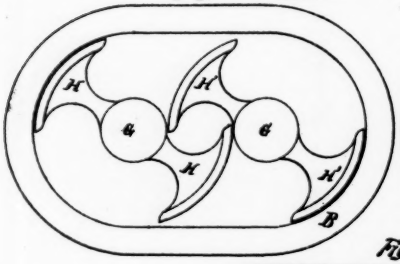


Fig. 5.

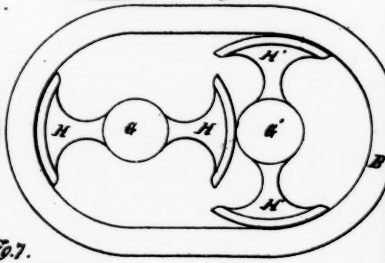
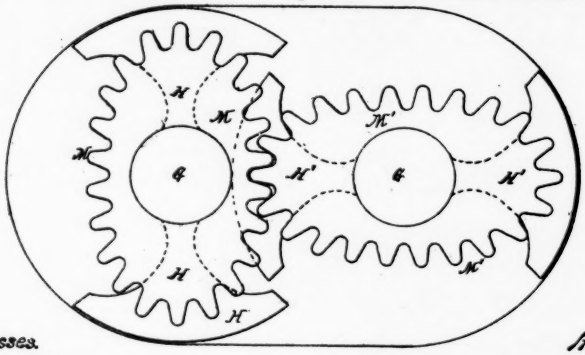


Fig. 7.



Witnesses.

L. Van Riswick

H. G. Stuart

Inventor.

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per S. Hannay

Atty.

heet 2.

1876.

Inventor.
l Fette

Hannay,
Atty.

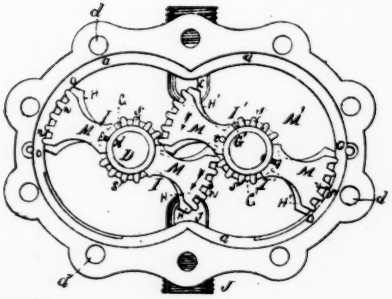
3 Sheets—Sheet 1.

B. FITTS.

WATER-METER.

No. 178,829. Patented June 13, 1876.

Fig. 1.



No. 192.
Natl Meter Co.
v.
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Comrs or.
p. 206.

Fig. 2.

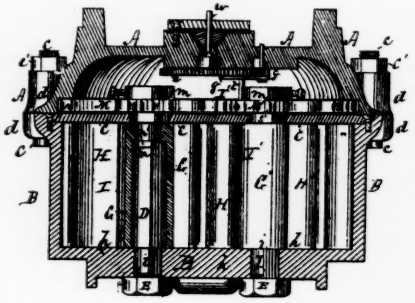


Fig. 3.

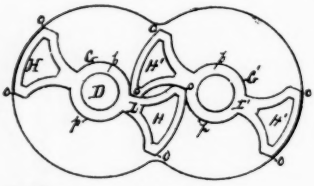
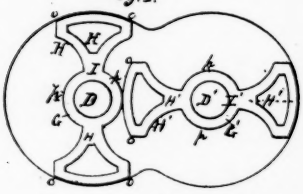


Fig. 4.



Witnesses.
L. Van Riswick
D. G. Stuart

Inventor.
Benaiah Fitts
per P. Hannay

209 UNITED STATES PATENT OFFICE.

BENAIAH FITTS, of Worcester, Massachusetts, assignor to Union Water Meter Company, of same place.

Improvement in Water-Meters.

Specification forming part of Letters Patent No. 178,829, dated June 13, 1876; application filed May 18, 1875.

To all whom it may concern:

Be it known that I, Benaiah Fitts, of Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful improvements in water-meters; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification, in which—

(Here follow diagrams marked pp. 206, 207, & 208.)

Figure 1 represents a plan of my improved meter, the cover and partition-plate being removed in order to show the relation of the rotary pistons and gears to each other. Fig. 2 represents a vertical longitudinal section of the same as taken through the center of the apparatus, but showing the cover, partition-plate, and the driving portion of the registering apparatus in position, the last, as well as the gears and pistons, being shown in elevation, with the exception of the hub of one of the pistons, which is shown in section to illustrate the method of mounting the piston on its stud. Figs. 3 and 4 are diagrams illustrative of the relative movements of the rotary pistons with respect to each other at different points of their circuit, Fig. 3 being that shown in Fig. 1, and Fig. 4 when at right angles to each other. Figs. 5 and 6 represent similar diagrams of a modified form of the pistons, the relative positions of which are the same as those shown in Figs. 3 and 4. Fig. 7 illustrates, on a somewhat larger scale, a modified form of gear for driving the pistons, and well adapted to the form of pistons shown in Figs. 5 and 6, and shows the relative position of the gears to the pistons. Fig. 8 represents a similar plan to that shown in Fig. 1 of a modified form of my improved meter, each hub carrying three instead of two pistons, as in the former case. Fig. 9 represents a vertical longitudinal section of the same; and Fig. 10 a plan similar to Fig. 8, but showing one of the changes in the relative position of the pistons and gears as they perform their circuit.

My improvement relates solely to rotary fluid-meters as contradistinguished from reciprocating meters.

My invention consists, first, in constructing those portions of a set of radial pistons, which, when combined with another set, re-

spectively come in contact with the relatively-corresponding portions of the other set, in segments of concentric circles.

Secondly, it consists in so arranging and combining two sets of radial pistons thus constructed that when in position the periphery of the pistons of each set shall, respectively, extend to, bear against, and form a close joint with the smaller segmental portions of each other, and in such manner that there shall always be contact during every stage of their revolution between a radial piston of the one set and the corresponding smaller segmental portion of the other set, and this alternately and successively.

Thirdly, it consists in combining with the two sets of pistons thus arranged and constructed, gears of like and suitable construction, such as those to be hereinafter described, by which not only to confine them to their proper relative positions with regard to each other, but to prevent interference between the pistons of each set as they are made to revolve by the pressure of the water or other fluid being measured.

Fourthly, it consists in mounting or supporting each set of radial pistons on steps or stubs by means of a hub on which they are formed or otherwise secured, the upper or outer end of which forms the shaft on which the gears are made fast.

Fifthly, it consists in combining with two sets of measuring-pistons thus constructed and arranged suitable mechanism, such as will be hereafter described, for driving the registering apparatus.

To enable others skilled in the art to make, construct, and use my invention, I will now proceed to describe its parts in detail.

The shell of the apparatus I propose to make in two principal parts, of which the cover or cap-piece A forms one and the lower portion of casing B the other. Between the two is arranged a metallic diaphragm or partition-plate, C, which fits in a depression, *a* (see Fig. 1), formed on the upper internal edge of the casing B. Partition C is secured by screws *b* to casing, as shown in Fig. 2. Cover A is secured to casing B by screw-bolts *c* and nuts *c'*, which
210 are made to pass through corresponding lugs *d d*, formed on each. Cover A carries or supports the registering apparatus of the meter, of which the transmitting-gear *e*, driving-pinion *f*, and actuating-crank *g* are only represented in the drawing, as the balance is made and applied in the usual manner, and therefore unnecessary here to be described or shown. In the bottom plate *h* of casing B, at a regulated distance apart (see Fig 2), are cut two openings, *i i*, for the reception of the ends of two studs, D D'. The lower end of each of these studs is made of smaller diameter than their upper end, and are made to project through the bottom plate *h* sufficiently far to receive a screw-nut, E, they being provided with a corresponding screw-thread, by which to secure them firmly to the bottom plate, and with a water-tight joint. Or, instead of making and securing them in that manner, they may be cast in one piece with bottom plate *h*, as shown in Fig. 9; but the former is preferred, as it is easier to turn them, that they may form a smooth and suitable axial stud for the hub of the piston. Upon each of these studs D D', and which are made to extend upward to within a

short distance of the under side of partition C, is mounted a piston-frame, I or I′, by means of a hub, G or G′, each carrying two or more radial piston-blades, H or H′. In Figs. 1 and 2, stud D supports a piston-frame, consisting of a hub, G, cast in one piece, I, with two radial pistons, H H, while stud D′ carries a corresponding piston-frame in every respect, consisting of hub G′ and pistons H′ H′. If desired, the hubs and pistons may be made separately and afterward secured to each other, but the other is preferred. In this case the pistons H H and H′ H′ are arranged on the diametrically opposite sides of their respective hubs. The upper end of each hub is made to extend through and for some distance above partition-plate C, so as to receive a gear, M, for hub G and gear M′ for hub G′. These gears are keyed, as in Fig. 9, or otherwise made fast to the hubs, as, for instance, by means of a screw, *l*, passing through a collar, *m*, formed on them as a hub for the purpose, and into an indentation made in the side of their hubs G and G′, as shown in Figs. 1 and 2. Referring to Fig. 9, where the hubs, studs, gears, and partition are all shown in section, it will be seen that the upper end of the hubs G or G′ are turned down as they enter partition-plate C, so as to form a shoulder to abut against the under side of the latter, and yet further turn down as they leave it so as to form another shoulder for the under side of the gears M M′ to abut and bear against when keyed or otherwise made fast thereto.

Moreover, from the same figure, it will also be seen that the cylindrical opening through the hubs, for the reception of their axial studs D or D′, are not of uniform width throughout, it being made smaller at their upper end, and into which is snugly fitted a pin, *n*′, having a head, *n*, of a size equal to, or nearly so, of the diameter of the studs. The thickness of the head of pin *n*′, which forms the actual support of the whole piston-frame—*i. e.*, hub and pistons, as well as gears—is such as to just support and carry the lower edges of the pistons H or H′, and their hubs G or G′, clear of the inner face of the bottom plate *h* of casing B. The vertical depth or acting faces of the pistons extend from the inner faces of partition C and bottom plate *h* of casing B.

Figs. 3, 4, 5, 6, and 7 illustrate suitable external shapes of the pistons, where two are used as a full set for each of the two piston-frames; and Figs. 1 and 7 the relative arrangement of the gears, with respect to the pistons. Figs. 8 and 9 represent suitable shapes for pistons, where each piston-head carries three pistons; and Fig. 8 suitably-shaped gears, properly arranged with respect to the pistons to operate in connection therewith.

The leading features of these pistons consists in making the curved portion of the outer end or face of the pistons—say, from *o* to *o*—and the outer face of those portions—say, from *p* to *p* of the hubs—contained between the radial arms, which constitute the pistons, segments of concentric circles struck from their center of motion. By this means, when the outer curved face *o* of the pistons is brought in contact with the curved face *p* of the hubs, the joint is not affected by imperfections or wear of the outside gears.

Theoretically the distance apart from center to center of the studs

D D′ should be the length of any of the piston-blades H or H′, from its center to its periphery—plus the length of the radius of the hub, as taken at any point between the curved portions *p p* and its center of motion; but practically it should be the veriest trifle more.

In Figs. 1 and 2, the gears are shown as consisting of the segmental variety, each gear M or M′ consisting of four segmental gears concentrically arranged in pairs and conforming in their arrangement and position to the curved portions *o o* of the pistons and *p p* of the hubs, the curved form of the periphery of the pistons and hub being precisely that of the pitch-line of the gears—that is to say, gears *r r* with the curves *o o* of the pistons, and gears *s s* with the hub-curve *p p*.

By this construction of the gears, pistons, and hubs a constant tight joint between the pistons and hubs is insured, as thereby an easy rolling instead of a sliding joint is obtained; while the piston-blade that drives has the advantage at all times of its small hub-gear *s* working into the larger gear *r* of the other, and consequently the advantage of leverage. This motion also serves to make the pistons clear each other, the one for this purpose being made alternately to move faster and slower than the other, the piston whose small gear *s* is engaged with the large gear of the other being made to move for the time being faster than the latter, thus moving its own piston away from the advance of the piston it is then driving. Let
211 us take, for instance, the position of the pistons, as shown in Fig. 1, they moving in the direction of the arrows. The outer piston I, by its small gear *s*, is now driving the inner piston I′ through its large gear *r*; and, consequently, to do so must move relatively faster than the latter piston, thus moving its own opposite piston I away from the advance of piston I′ faster than the latter can advance, because of the greater arc its gear *r* has to traverse, than the smaller arc of gear *s* with which it is in gear.

Ordinarily, either of the ports J and K may be the eduction or induction ports of the meter; but in this instance, the pistons moving in the direction of the arrow, port J forms the induction and K the eduction ports.

To the upper side of gear-plate M′ that carries the segmental gears *r* and *s*, and immediately adjoining its hub or collar *m′*, is secured a crank-pin, *t*, which, engaging with crank-arm *g* of the driving-pinion *f*, imparts motion to gear *e*. On the inner end of the spindle *w* is mounted the pinion that drives the train of gears, the spindles of which carry the index-fingers of an ordinary registering apparatus, and which it is deemed unnecessary to be further referred to or described, as such may be of any improved, known, and suitable variety.

In Fig. 7 is shown a somewhat different style of variable gears, in which but two are used, they also being intended to be employed in connection with hubs G and G′, which carry two radial arms or pistons, I I′, constructed substantially like those in Figs. 1 and 2. In this case, with the same distance from center to center of the studs D D′, the hubs G G′ are relatively larger, and pistons smaller, than the hubs and pistons in the former case, and are connected

and operated in connection with gears of correspondingly greater and less minor and major axes or diameters, resulting in oval-shaped gears of uniform size and number of teeth, the latter being suitably shaped to adapt them to their change of form. With those gears the longer diameter corresponds with the length of the pistons, and their shorter or conjugate axis with that of the hubs, and are so combined that the teeth at the end of the longer axis mesh with those of the shorter, thereby producing substantially the same effect as that produced by the segmental gears, in the apparatus shown in Figs. 1 and 2. The difference is, the latter can be made to operate with a lower head or smaller stream of water than can be done by the former.

In Figs. 8 and 10 a meter having my improvement applied thereto is shown in connection with two hubs, G G′, each of which carry three radial blades or pistons, I I′. Such a construction requires a corresponding change in the variable gears, in order that the pistons may properly clear and operate each other. A suitable form for this purpose is shown, consisting of triangular gears M M′ provided with teeth of suitable pitch. These gears are arranged with respect to each other and to their respective pistons on precisely the same principles as those already described and shown in Figs. 1 and 7, and operate on the same plan, the teeth at the apices of the angles being respectively in a line, or nearly so, with the radial arms, and with respect to each other, so that the apex or longest radial tooth of the one—say, No. 1 of gear M—shall take into the shortest corresponding radial depression, No. 1, of the other, M′, and so on, producing substantially the same effect as in the others.

Again, by placing the studs D D′ somewhat further apart, and then making the curved parts *p p* of the hub of each correspondingly larger, then circular gears may be used, but it would not shed nearly as much water, although it would make a good motor.

In all cases the working portions of the inner face of the casing B are made to conform to the sweep of the pistons, with the exception of that portion adjoining the mouths of the induction and eduction openings J and K, which do not absolutely conform.

Having described my invention, what I claim as new, and desire to secure by letters patent, is—

1. The combination of two eccentric gears, M and M′, with two rotary pistons, I I′, each consisting of two or more radial piston-blades having a curved outer end, *o*, and of a hub, G, provided with two or more curved portions, *p p*, substantially as and for the purposes set forth.

2. The combination of two pistons, I I′, constructed and arranged substantially as described, with two gear-plates, I I′, each carrying four concentric segmental gears, *r r* and *s s*, in the manner and for the purposes set forth.

3. The combination of a rotary piston provided with two or more radial piston-blades and a hollow hub, with a stud formed on or otherwise rigidly secured to the bottom plate *h* of the casing, in the manner substantially as and for the purposes set forth.

4. In combination, with the two rotary pistons and gears of a meter, the pin *t*, spindle *v*, and its crank *g*, as a means of imparting motion to the mechanism of a registering apparatus, substantially as described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

BENAIAH FITTS.

Witnesses:
ABIEL E. WILSON.
S. AUGUSTUS WELCH.

220 UNITED STATES PATENT OFFICE.

JAMES A. TILDEN, of Hyde Park, assignor to Hersey Brothers, of Boston, Massachusetts.

Rotary Fluid-Meter.

Specification forming part of Letters Patent No. 324,503, dated August 18, 1885; application filed December 22, 1884. (Model.)

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid-meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification in explaining its nature.

It is well known that a fluid-meter to be commercially successful must be capable of perfectly measuring or indicating the quantity of fluid which passes through it, regardless of the size of the stream, its speed, head, or any other condition, that it must not get easily out of repair, that its construction must be simple, and its manufacture inexpensive, and various meters have been made with some if not all of these conditions, but, so far as I am aware, there is not at present in the market any meter which combines all of these features with certain necessary wearing qualities to such an extent that it may be said to be a really commercially successful or practical meter; and while my invention may not be perfect in every respect, yet it has all the requisites of an efficient, desirable, and cheap meter.

The principle upon which the meter is constructed is so simple that but vey few parts or pieces are necessary and very little machine-work required in fitting them, and these can be placed in such very small compass that the weight of metal necessary for the casing is very small.

The invention comprises, broadly speaking, a chamber having inlet and exhaust ports, and a piston for opening and closing the exhaust-ports. The meter can hardly be called a "rotary" meter, because the piston does not rotate, and yet it is quite unlike in appearance any of the ordinary reciprocating-piston meters; but it combines, it may be said, portions of both systems in substantially this manner. The measuring-chamber of the meter is divided or separated upon its outer edge into measuring spaces or recesses, all of which open into the central portion of the chamber, but which may or may not be of uniform size and shape. Each of these spaces has its individual inlet and exhaust ports. The part which I call the "piston" has a radially-extending portion or lobe, which enters each measuring space or recess and does not at any time leave it, and has a movement therein that causes it to be brought into contact with one side of each recess near the mouth and to

advance along the side continuously until it reaches the other side of the recess, when it returns across the mouth of the recess or space to its original position. This movement of each lobe in each space or recess alternately exposes and closes the exhaust-ports, thereby preventing the flow of liquid from the chamber only after it has entered what may be termed the "measuring" and "discharging" spaces or recesses. The sides of the chamber and the sides of the piston should be parallel when the piston is centrally located in the chamber.

To understand the working of the device, it must be borne in mind that the liquid has free access to the chamber—that is, its inlet-ports are never entirely closed—that because of the shape of the wall of the chamber and of the piston, the piston is kept in contact with the wall of the chamber at a number of what I call "contact" points or lines, which form in the measuring and discharging passages spaces or recesses. The number of lines of contact depend, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary, because a full head is maintained in the larger part of the chamber, and it is of course necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by liquid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes in connection with the portions of the wall which constitute or form the spaces or recesses also act to separate the exhaust-ports from the inlet-ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact-lines, one between the outer surface of the lobe and the wall of the recess, and the other between the surface of the inward projection of the wall and the surface of the piston
221 between the lobes. These lines of contact continually advance until the water has been expelled from each space or recess. While, however, this discharge from each space or recess is going on by the movement of the lobe, the space or recess is filling behind the lobe. Of course the number of spaces or recesses which are discharging simultaneously depend upon the entire number of spaces or recesses which the chamber contains, and there may be several recesses or spaces discharging and receiving at the same time. This advancing movement of the lobe in each space or recess does not continue beyond its individual space, but upon reaching the end of that space or recess it returns across the mouth or entrance of its recess or space to its original position, while the piston as a whole, without revolving, moves on a circular path.

In the drawings—

(Here follow diagrams marked pp. 212, 213, 214, 215, 216, 217, 218, & 219.)

Figure 1 represents a side elevation of the machine. Fig. 2 is a plan view of a portion of the meter above the line *x x* of Fig. 1, inverted, showing the piston and upper series of exhaust-ports. Fig. 3 is a view, principally in vertical central section, showing,

(Model.) 8 Sheets—Sheet 1.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

No. 192.
Natl Meter Co. } p. 212
v.
Bd. Water Comrs

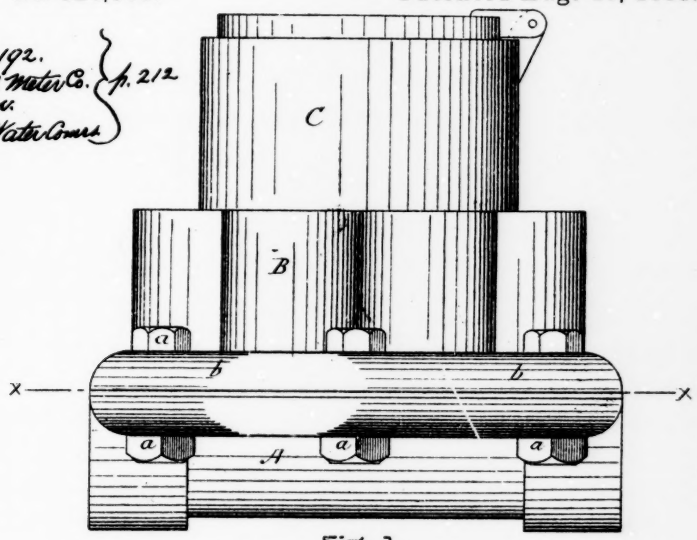


Fig. 1.

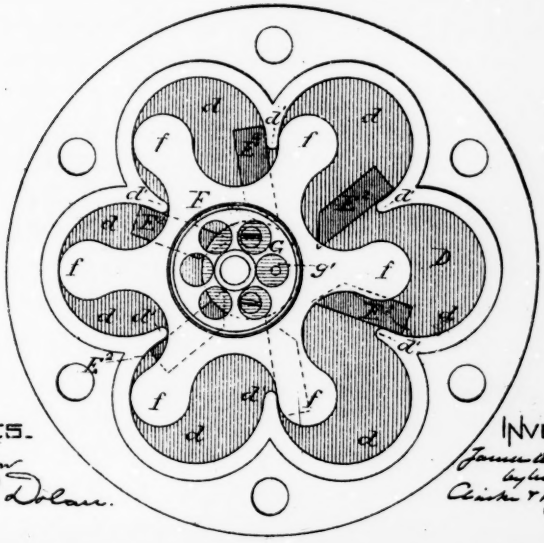


Fig. 2.

WITNESSES.
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INVENTOR.
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Clarke & Raymond.

(Model.) 8 Sheets—Sheet 2.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

Fig. 20.

Fig. 21.

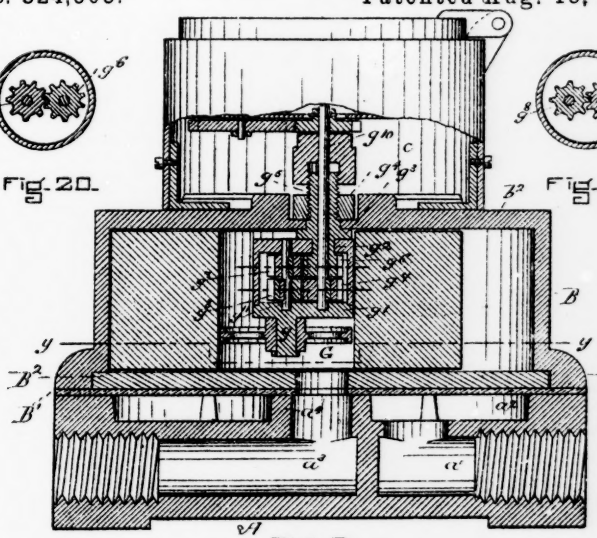

Fig. 3.

No. 192.
Nat. Meter Co.
v.
Bd. Water Comrs.
} p. 213.

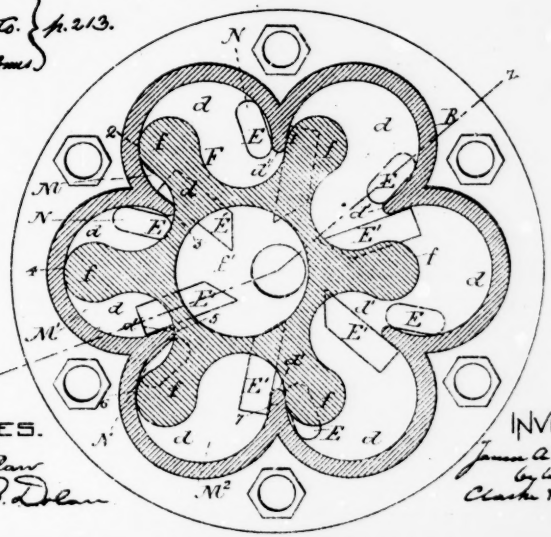

Fig. 4.

WITNESSES.
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(Model.) 8 Sheets—Sheet 3

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

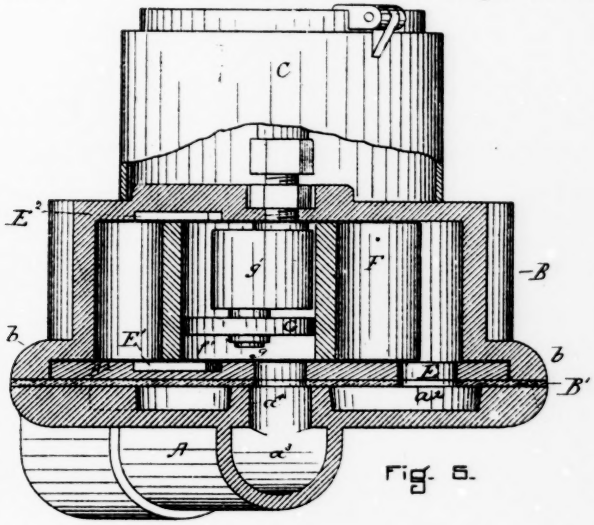

Fig. 5.

No. 192.
Nat'l Meter Co. } p. 214.
vs.
Bd. Water Comrs.

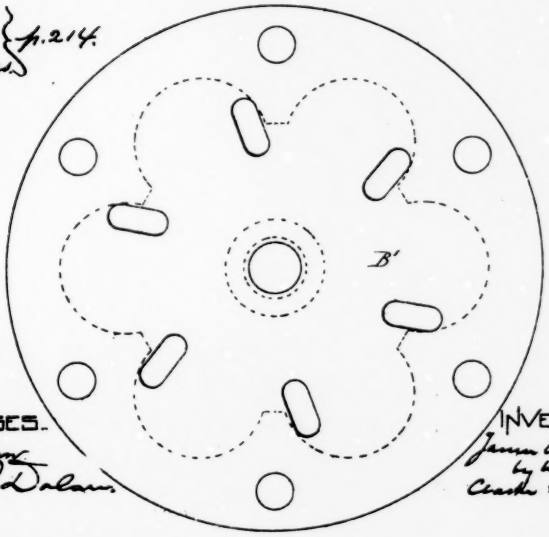

Fig. 6.

WITNESSES.
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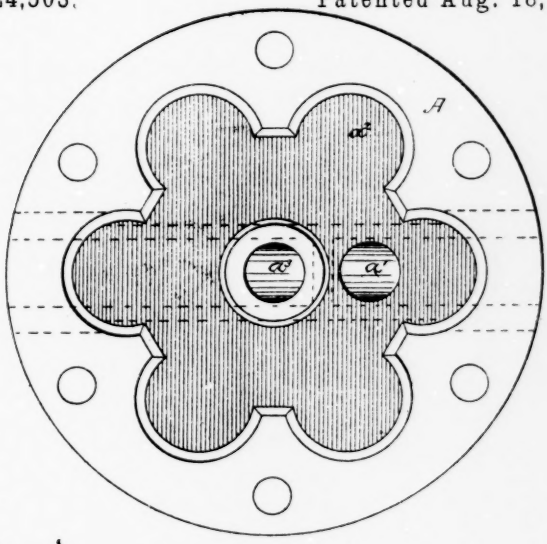
(Model.) 8 Sheets—Sheet 4.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.



No 192.
Hall Meter Co.
v.
B'd Water Comrs.
p. 215.

Fig. 7.

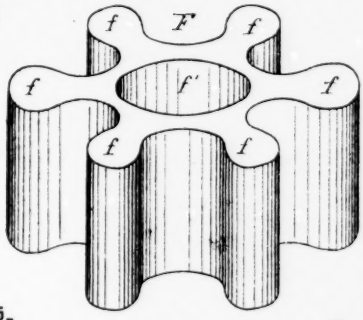


Fig. 8.

WITNESSES.
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(Model.) 8 Sheets—Sheet 5.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

No 192. Nott Meter Co. v. Bd. Water Comrs. } p. 216

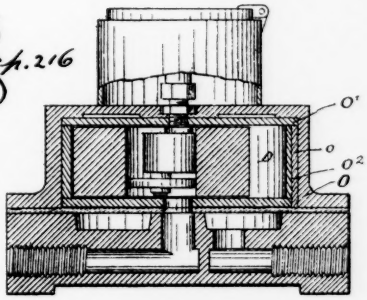

Fig. 9.

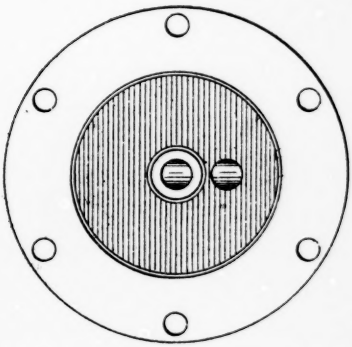

Fig. 10.

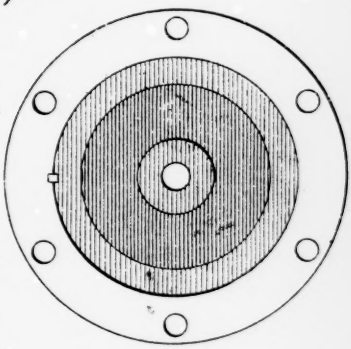

Fig. 11.

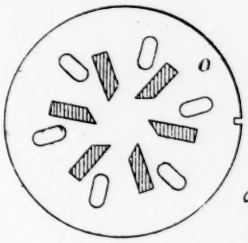

Fig. 12.

WITNESSES.
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(Model.) 8 Sheets—Sheet 6.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

No. 192.
Nott Meter Co. } p. 217.
v.
Bd Water Comrs

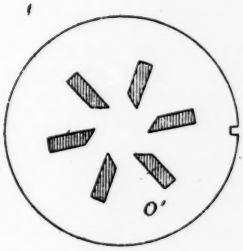

Fig. 13.

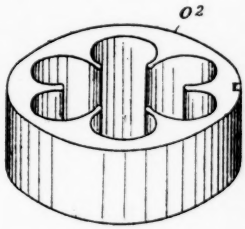

Fig. 14.

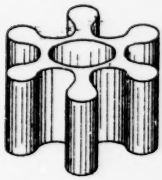

Fig. 15.

Fig. 22.

WITNESSES.
J. M. Dolan
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(Model.) 8 Sheets—Sheet 7

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

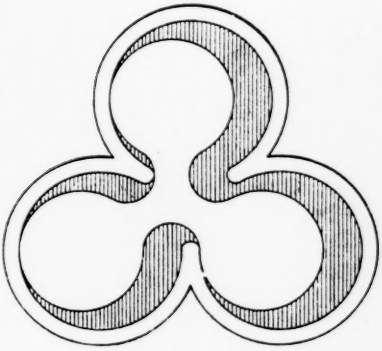

Fig. 16.

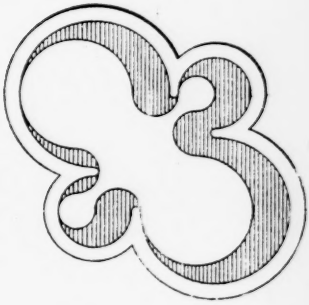

Fig. 17.

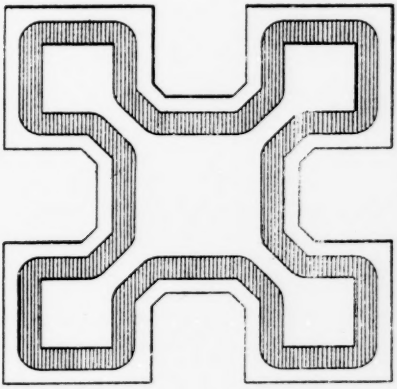

Fig. 18.

No. 192
Natl Metr Co.
v.
Bd Water
Comrs.
p. 218.

WITNESSES.

J. M. Dolan
Fred. B. Dolan

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(Model.) 8 Sheets—Sheet 8.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

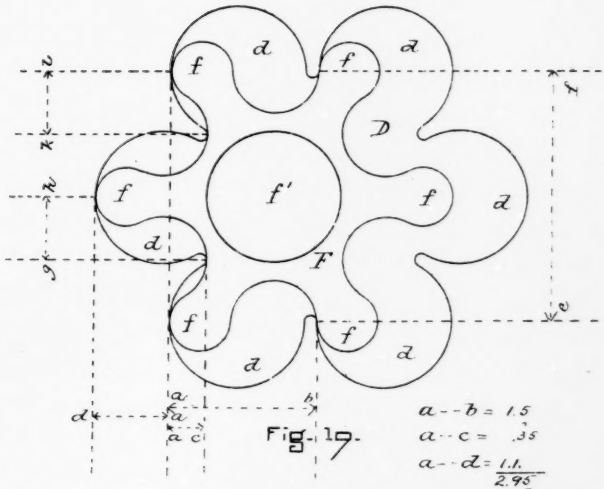

Fig. 10.

$a - b = 1.5$

$a - c = .35$

$a - d = \frac{1.1}{2.95}$

1.5

Rotative effect 4.425 sq. in.

$e - f = 2.6 \times 1.5 = 3.90$

$g - h = .65$

$k - l = \frac{.65}{1.30 \times 1.5} = \frac{1.95}{1.95}$ sq. in.

Excess pressure

No. 192.
Hall Meter Co.
v.
Bd Water Comrs.
p. 219.

WITNESSES.

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Fred B. Dolan

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Clarke & Raymond.

especially, the mechanism for connecting the piston with the registering-train. Fig. 4 is a section upon the line *y y* of Fig. 3, also showing the lower series of exhaust-ports and the inlet-ports. Fig. 5 is a view, principally in vertical section, upon the lines *z z* of Fig. 4, showing, especially, the relation of the exhaust-ports, meter-walls, and spaces or recesses when discharging. Fig. 6 is a plan view of the packing-piece between the base and main sections of the meter. Fig. 7 is a plan view of the base-section, showing the receiving-chamber and the inlet and outlet passages. Fig. 8 is a perspective view of the piston. Figs. 9 to 15, inclusive, illustrate special details of a modified form of construction. Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction. Fig. 19 is a diagram showing by calculation the differences in pressure which cause the action of the meter. Figs. 20 and 21 are sections of the reducing-gears hereinafter described, and Fig. 22 is a view of the sleeve forming the support of the drum carrying the gears.

Preferably, the casing of the meter comprises three principal parts or sections—first, the base-section A; second, the body or main section B, and, third, the shell C, forming the chamber *c*, containing the registering mechanism.

The base-section is made somewhat larger in circumference than the main section, and the two parts are fastened together by bolts *a*, which pass through the flange *b* of the main section. The base-section has the inlet-passage a', which opens into the distributing-chamber a^2 and the outlet-passage a^3. The distributing-chamber a^2 occupies almost the entire upper portion of the base, and its object is to provide means for the ready distribution of fluid simultaneously through the various inlet-ports to the main chamber D.

Between the sections A B is a packing-ring, B′, which is shaped as shown in Fig. 6, and is provided with holes for the bolt-holes, the inlet-ports, and outlet-passage. Above this packing-ring is a metal plate, B^2, which may be called a "port-plate." It rests upon the packing-ring B′, and is held or fastened in place upon it and the upper surface of section A, surrounding the chamber a^2 and the central projection, a^4, by the bolts *a*, the plate being within the main section B and its edge projecting into a recess formed in the under edge thereof. This port-plate has the holes E, which form the inlet-ports to the chamber D and connect the distributing-chamber a^2 therewith. These ports E are arranged, preferably, to open into each space or recess *d* of the chamber D at one side thereof. The port-plate also has a central hole, which forms a portion of the outlet a^3 and the escape or exhaust ports E′, which are recesses formed in the upper surface of the plate, and arranged to extend from one side of each recess or space *d* inward upon converging lines. The chamber D has the measuring recesses or spaces *d* arranged about its outer edge, which open into the central portion, and the projections or portions of the wall of the chamber which form spaces or recesses I have lettered *d*′. The piston F preferably is made of hard vulcanized india-rubber, gutta-percha, or other equivalent material,

and has the wings or lobes f, which extend radially therefrom, and the central hole, f'.

For the best working of the device it is desirable, but not essential, that the surface of the piston, when the same is centrally located in the chamber D, shall be parallel with the surface of the chamber, so that as the surface of the chamber is made up of alternating recesses and projections, so the surface of the pistons is made up of alternating lobes and recesses. The central hole, f', of the piston forms a part of the exhaust or outlet passage, and is large enough to always permit the escape of fluid therefrom into the outlet a^3, regardless of the position of the piston.

In addition to the lower set of exhaust-ports, E', I have formed in the under surface of the upper plate, b^2, which forms the top of the main section B, another set of exhaust-ports, E^2. (Shown in Fig. 2.) They are of the same shape and connect the same parts of the spaces or recesses with the opening f' as the lower exhaust-ports, E'. There is also arranged in the hole f' a perforated disk, G, (see Figs. 2 and 3,) by which motion is communicated to the shaft which operates the train of gears comprising the registering mechanism. This disk carries at its center a stud, g, which projects downward from the drum g', which is pivoted at g^2 to the screw-sleeve g^3, which passes through the hole in the plate b^2, and is locked thereto by the nut g^4, which screws upon the thread g^5, and the movement of the piston causes the drum to be revolved upon the sleeve—that is, the drum and stud form substantially a crank.

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It is necessary, however, as the chamber is of small capacity and as the motion of the piston is rapid, to reduce the motion of the piston very considerably, and it is desirable to do so in as simple a manner and with as few parts as possible, in order that the construction may be cheap and as little weight of metal used as possible; and I employ for this purpose a train of four gears, one of which, g^6, is stationary, being secured to the end of the sleeve g^3. The gears g^7 g^8 are attached to the drum by the shaft or pinion g^9, to which they are keyed, and the gear g^7 meshes with the gear g^6. The gear g^8 is arranged to mesh with the fourth gear, g^9, which is keyed or fastened to the spindle g^{10}, which communicates motion to the registering-train. As the drum revolves about the sleeve g^2, it is obvious that if the gear g^7 has more or less teeth than the gear g^6 it will be caused to move each revolution of the drum a certain portion of a revolution depending upon the difference in the number of teeth between the two gears. It is also obvious that if the gears g^8 g^9 have the same number of teeth as the gear g^7, a movement of rotation will be communicated to the shafts or spindle g^{10}. If it is desired to still further reduce or change the rate of the rotation of the shaft g^{10}, then the gear g^8 may have more or less teeth than the gear g^7, as the case may be, as also may the gear g^9; and in the drawings I have represented the gear g^6 as provided with ten teeth, the gear g^7 with nine teeth, the gear g^8 with eight teeth, the gear g^9 with nine teeth, so that upon every complete revolution of the drum the shaft g^{10} is moved one eighty-first of a revolution, and it therefore requires eighty revolutions of the drum to make one complete

revolution of the shaft, the spindle or shaft g^{10} being used, of course, to operate any registering mechanism.

It will be seen by this construction of gearing that the drum g', carrying the gears g^7 g^8, revolves from left to right, and that the gear-wheels g^7 g^8, being carried by the drum, are caused by the meshing of the gear g^7 with the stationary gear g^6 to turn from right to left, and that the meshing of the gear g^8, as it is turned upon its revolution about the gear g^9, causes the gear g^9 to be moved, as above specified, one eighty-first of a revolution for each revolution of the drum and the gears g^7 g^8 about it.

In operation the liquid passes into the distribution-chamber a^2 and through the inlet-ports E into the chamber D, moving the piston toward one side of the chamber and causing the formation of measuring or discharge spaces by the contact of the various portions of the piston with the chamber-wall. This position of the piston is well shown in Fig. 4, where there have been formed six divisions of the three spaces or recesses d by the contacting of the piston at the points 1, 2, 3, 4, 5, 6, and 7, and of these three recesses or spaces, two—namely, the small spaces marked M and the space M′—are connected by the discharge-ports E′ E^2 with the escape-passage, while the space M^2 is about to be; but the fluid, upon being admitted to the chamber under pressure, not only immediately moves the piston to the position shown in Fig. 4, which is one of any number of positions which it might cause it to assume, and from such position it causes it to advance or move, so that the lobes which are in contact with the wall of the chamber are caused to continue that contact until they have expelled all the fluid which is in the discharge spaces or recesses before them, when each lobe in succession will leave the surface and return upon an arc of a circle to a position where it again comes in contact with the surface of the wall of the chamber on the opposite side from that which it left, and again advances and expels the fluid from its recess or space.

It will be seen that each recess or space becomes in succession a discharge space or recess, and that as soon as the piston has moved sufficiently to uncover the inner end of its escape-ports it begins to discharge through such ports into the escape-passages b^3 a^3, and that while a portion of each space or recess is discharging another portion is also receiving the liquid under pressure through the ports E.

To illustrate why with the arrangement of the inlet and exhaust-ports described the piston is compelled to make the motion that it does, I have shown in Fig. 19 by diagrams the differences in pressure upon both sides of the piston and the extent of the surface which is subjected to the direct pressure of the entering fluid.

It is obvious that the chamber D, excepting the spaces which are discharging, is filled with fluid under pressure, and that the pressure for moving the pistons is that which enters each space or recess which is being discharged, and behind the respective discharging lobe-. For instance, referring to Fig. 4, the piston is receiving motion from the fluid which enters the spaces through the ports marked N N N, but from no other. It is not necessary that the main

chamber and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses, from three upward, and that they may be of any size and of different sizes for the same piston, the only difference to be observed being that the piston and chamber-wall must be so shaped as to provide the contact-lines in the surface of the piston or chamber-wall, whereby the formation of measuring-chambers is effected.

In Fig. 16 I have illustrated a piston having three lobes in a chamber having three measuring and discharge spaces or recesses. In Fig. 17 I have shown a piston with two large lobes and two small ones, and a chamber with corresponding recesses or spaces. In Fig. 18 I have represented the piston as having square lobes, and the chamber with spaces which substantially follow the shape of the lobes, the only variation being that they are rounded at the corners.

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It will be obvious from what I have stated that the meter is very simple in construction, that it has but very few parts, which require but little machine-work and are easily fitted and put together, and it is also apparent that a substantially-perfect registration of the the liquid which passes through the meter is obtained, as it all is obliged to pass into the measuring-spaces, which are successively emptied. It will be seen, further, that this measuring of the liquid takes place very rapidly, and with comparatively very little friction of the wearing parts, and that the construction of the piston and chamber is such that sediment cannot interfere with the proper working of the invention, and that wear, up to a certain extent, improves the efficiency of the meter in that it causes the contacting surfaces of the piston and chamber to fit themselves as they wear.

To still further cheapen the manufacture I show in Figs. 9 to 15, inclusive, a construction which enables me to use, instead of the comparatively expensive casing of composition, an iron casing. This I accomplish by making the base-section entirely of iron, employing two composition port-plates, O O′, the plate O being like that described, and the plate O′ having simply the exhaust-passage E^2. The piston is made of hard rubber, gutta-percha, or other like non-corrosive material, and the wall O^2 (see Fig. 14) of the chamber D is formed of a ring or sleeve of gutta-percha, hard india-rubber, or even of composition, which is fitted into the iron shell or casing of the main section. This non-corrosive movable wall of the chamber is fastened to the casing by means of a key, *o*, which enters a groove in the ring and a corresponding one in the inner surface of the iron shell, or in any other suitable way. A view in perspective of the movable wall is shown in Fig. 14.

It will be seen that by this construction not only can an iron shell be employed, but that the principal wearing parts—namely, the port-plates, the piston, and the wall of the chamber—may be easily removed and others substituted therefor. The port-plates are also held in place by suitable keys or in any other desirable way, and it will be observed that they extend upon the two end surfaces of the removable wall. (See Fig. 9.)

Of course the invention can be utilized as a pump or motor, if desired.

It will be observed that by making the mechanism for reducing the movement of the piston in compact form, I am enabled to place it in the measuring-chamber and within the hole formed in the piston, thereby economizing space.

As the gears are inclosed in a drum or casing, no sediment can reach them to disturb their easy action.

While the invention as shown in the drawings represents a piston which, while not rotating moves in a circular path, yet by changing the forms of the piston-lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, elliptical, or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston the principle of its action is not changed, as the lobe or portion of the piston which penetrates the measuring-space will have a continuous movement in said space, whether its path be circular, square, rectangular, elliptical, or of any other shape.

It will be seen that the contacting points or lines of the piston or valve are, in the operation of dividing the chamber into measuring-spaces or recesses and discharging the same, always upon the one side of the piston, and that these contacting points are brought successively into operation, not by the rotation of the piston or valve, but by their successive reverse movements, so that the piston or valve, while appearing more like a rotating piston or valve, is in principle more like a reciprocating piston or valve, in that each of its lobes or projections is caused to enter a measuring space or recess, advance therein, empty it, and return to its original position to again advance in the said space or recess and empty. In making this movement the contact between each lobe and the wall is not maintained during the reverse movement of each lobe or projection.

It will further be seen that by this construction the contacting points always being upon one side of the piston, and the piston being held against the wall of the chamber by the water-pressure behind, or that not included within the contact-lines, it is very loosely fitted within the chamber, so loosely, indeed, that it is free to be moved back and forward therein the depth of a measuring space or chamber, and is dependent upon the water-pressure for maintaining the proper contact with the walls of the chamber and for its operation.

It will further be seen that from this principle of construction there can be very little friction between the running parts, and that sediment or foreign substances cannot interfere with the fine and regular working of the device.

It will also be noticed that the piston in other respects has more of the principle of a reciprocating piston than of a rotating piston, in that each lobe or projection operates as a separate or distinct pis-

ton or discharging device in connection with its respective space or recess, so that the recess or space being filled with liquid, the lobe enters it and presses the liquid therefrom through the exhaust-port.

In other words, each lobe or projection does not act to displace the liquid from the spaces or recesses, but to discharge the
224 liquid therefrom by an advancing movement from one end of the chamber or recess to the other.

It will be seen that the piston is made to fit the piston-chamber loosely, and that the necessary contact between its contacting-surfaces and the wall of the chamber is obtained and maintained by so arranging the contacting-points and the admission of pressure to the chamber that there shall always be a sufficient area of the piston exposed to the direct pressure to cause it to overcome all resistance and to keep it in contact with the wall of the chamber while it is being moved.

I have shown in Fig. 19 a diagram which illustrates this feature of construction, giving *for* the form of piston and piston-chamber therein shown, the area of the piston upon which the direct pressure is exerted, and the area upon which there is a resisting force; and it will — seen from the calculations noted upon said drawing that there is always an excess of pressure to maintain the piston in operation in working position. The said diagram and calculations also show how the rotative effect is obtained.

In order that this result may be obtained it is not only necessary that the piston be loosely fitted, but that its surface should be substantially parallel with the surface of the piston-chamber. It will also be seen that by forcing the piston against the wall of the chamber by excess of pressure from behind, instead of drawing it to the wall of the chamber by a crank or other rigid mechanical device, a substantially perfect contact must always ensue and continue, and that the piston is constantly fitted to the wall of the chamber as it wears, the very action of wearing tending to give it a better fit, while if a crank or rigid connection be employed there is no compensation for wear or opportunity for it.

Another advantage which arises from this form of construction and operation is that the meter is kept free from sediment, and the accidental lodging of foreign matter on the piston lobes or walls of the chamber cannot injure the meter or interfere with its practical working, as the lobe is pressed away by or rides over it, and it is then immediately washed off by the liquid.

It will also be observed that by making the wearing portions of the meter separate or detachable from the casing, as shown in Figs. 9 to 14, inclusive, the casing can be made of cast-iron, and the wearing parts of more expensive, durable, and non-corrosive material, thereby lessening the cost of construction, increasing the efficiency and life of the meter, and enabling repairs to be cheaply, economically, and readily made.

It will be observed that the reducing gearing and drum are contained in a recess within the piston, and that they are therefore within the piston-chamber, and that by so arranging them less space

is required than where they are placed without the piston-chamber, as is generally the case.

Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. In water meters, pumps, or motors, a piston-chamber having the measuring spaces or recess described, each of which has a separate inlet-port and a separate outlet-port directly connected therewith, as specified, in combination with a piston having a lobe or projection entering each of said spaces or recesses, and adapted to be brought in contact with the walls of the chamber by the excess of pressure from behind, whereby the lobes are given the successive movements in their respective spaces or recesses indicated, all as set forth.

2. In a water meter, pump, or motor, a chamber having measuring recesses or spaces opening therefrom, in combination with a piston having a separate lobe or projection entering each of said recesses or spaces, and adapted to be brought in contact with the walls thereof, and to be held in contact therewith during the movement of the piston by the direct pressure exerted upon the piston, as specified, all substantially as set forth.

3. In water meters, pumps, or motors, the combination of a piston-chamber having measuring spaces or recesses opening therefrom, each of which has an inlet-port and an outlet-port, with a piston having a lobe or projection entering each space or recess adapted to control the exhaust-port thereof and to maintain a contact with the wall of the space or recess, which contact is maintained by the excess of direct pressure in the piston-chamber, as described, all substantially as set forth.

4. In a water meter, motor, or pump, the piston-chamber having measuring recesses or spaces forming a part thereof, a piston, F, having a projection or lobe entering each of said spaces or recesses, which projections or lobes are adapted to be brought successively into contact with the walls of said spaces or recesses, and to be moved therein, and the contact maintained during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, a register, and devices connecting the piston with the register, all substantially as and for the purposes set forth.

5. In a water meter, motor, or pump, the piston-chamber having measuring spaces or recesses forming a part thereof, a distributing-chamber having an inlet, a', the passages or inlet-ports E, connecting the distributing-chamber with the measuring spaces or recesses of the piston-chamber, a piston having a separate or distinct lobe or projection which enters each of said measuring spaces or recesses and is operated or moved and the contact maintained by the excess of pressure, as herein set forth, all substantially as and for the purposes described.

6. In a water meter, motor, or pump, the combination of the distributing-chamber a^2, its inlet a', the piston-chamber D, having measuring recesses or spaces d, the uncontrolled ports or passages E, connecting the distributing-chamber a^2 with the

recesses or spaces d, the outlet-ports E′, and escape-passages connected therewith, and the piston F, having the lobes or projections f, one for each of the measuring spaces or recesses d, and operated or moved therein to maintain contact during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, all substantially as described.

7. In a water meter, motor, or pump, the independent or separate base-section containing the inlet-passage a', the distributing-chamber a^2, and the outlet-passage a^3, with the independent or separate section B, containing the piston-chamber D, with the measuring recesses or spaces d, connected with the distributing-chamber and outlet-passage, as described, and the piston F, having a lobe or projection for each of said spaces or recesses, and the bolts for fastening the two sections of the meter together, all substantially as and for the purposes described.

8. The combination of the section A, having the distributing-chamber a^2, the section B, and the removable port-plate B^2, having the ports E.

9. In a meter, motor, or pump, the combination of the section A, having the distributing-chamber a^2, the section B, containing the measuring-chamber, the port-plate B^2, and the packing-ring B′.

10. In a water meter as a means for communicating the motion of the piston to the register, the mechanism described, consisting of the stationary gear g^6, the revolving gears g^7 g^8, adapted to be revolved around the stationary gear by the piston, and the gear g^9 upon the connecting-spindle.

11. The combination of the piston F, the disk G, the drum or frame g^2, pivoted, as described, to be revolved, and the differential gears inclosed within said drum or case.

12. The combination, in a water meter, of the piston-chamber D, the piston F, the reducing mechanism or gearing for transmitting the motion of the piston to the registering device contained in a recess in the piston, and the registering mechanism, all substantially as and for the purposes described.

13. In a water meter, motor, or pump, a piston-chamber having measuring spaces or recesses, and a loosely-fitted piston having lobes or projections extending into said spaces or recesses to form by contact with the walls thereof successive discharge-spaces, the said walls being shaped to provide the surface of the piston within the contacting lines of the discharge-spaces with less area than the remainder of the piston, subjected to the direct action of the pressure from behind, whereby the piston or valve may be loosely fitted in the piston-chamber, and by the excess of pressure caused by the difference in area is brought in contact with the walls of the measuring spaces or recesses, maintained in contact therewith, and rotated, all substantially as described.

JAMES A. TILDEN.

Witnesses:
F. F. RAYMOND, 2D.
FRED. B. DOLAN.

234 UNITED STATES PATENT OFFICE.

JAMES A. TILDEN, of Hyde Park, Massachusetts, assignor by mesne assignments to the Hersey Meter Company, of Portland, Me.

Water-Meter with Revolving Pistons.

Specification forming part of Reissued Letters Patent No. 10778, dated November 2, 1886; original No. 324,503, dated August 18, 1885; application for reissue filed September 30, 1886. Serial No. 215,027.

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid-meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in explaining its nature.

It is well known that a fluid-meter, to be practically and commercially successful, must be capable of measuring and registering the quantity of fluid which passes through it under all conditions, that it must not easily get out of repair, that its construction must be simple, and that its manufacture must be inexpensive. Various meters have been made with some, if not all, of these requirements; but, so far as I am aware, there is not at present in the market any meter which combines all of these features with certain necessary wearing qualities to such an extent that it may be said to be a really commercially successful or practical meter; and while my invention may not be perfect in every respect, yet it has all the requisites of an efficient, desirable, and cheap meter.

The invention is embodied in a fluid-meter comprising a stationary chamber having measuring spaces or recesses opening therefrom, the ends of the chamber being closed by fixed parallel heads, whereby the weight and end pressure on the piston which moves therein are reduced; a piston of less diameter than that of said chamber accurately fitted between said heads, and having lobes or projections equal in number to the chamber-spaces, each lobe moving in and conforming in shape to its space; an inlet-port for the supply to each measuring-space of fluid under pressure, and outlet-ports at each end of the piston extending from each measuring-space to an escape-passage, whereby the piston is balanced in its function as a fluid-actuated valve. If the piston is placed centrally within the chamber, its irregular peripheral surface will be concentric to the opposed interior surface of the chamber, and the distance between said surfaces will be the radius of the extent of the piston's movement, which movement and its contact result not from mechanical means, but from hydraulic action of the fluid in passing through the meter, during which time the piston is eccentric within the chamber.

The meter can hardly be called a "rotary" meter, because the piston does not rotate on its own axis, although it does revolve about

the center of the case, and yet it is quite unlike in appearance any of the ordinary reciprocating-piston meters; but it combines, it may be said, portions of both systems in substantially this manner. The measuring-chamber of the meter is divided or separated upon its outer edge into measuring spaces or recesses, all of which open into the central portion of the chamber, but which may or may not be of uniform size and shape. Each of these spaces has its individual inlet and outlet ports. The part which I call the "piston" has radially-extending portions or lobes, each of which enters its measuring space or recess and does not at any time leave its recess, and has a movement therein that causes it to be brought into contact with one side of its recess near the mouth, and to advance along the side continuously until it reaches the other side of the recess, when it returns across the mouth of the recess or space to its original position. This movement of each lobe in each space or recess alternately exposes and closes the outlet-ports, thereby preventing the flow of liquid from the chamber only after it has entered what may be termed the "measuring" and "discharging" spaces or recesses.

The piston performs a double duty. It not only acts to form measuring-spaces and to discharge their contents, but the portions thereof which cover the outlet-ports also act as the valves of the piston-chamber, in that they serve alternately and in successive order to valvularly control or open and close the outlet-ports; and as it is essential that the piston should move in the piston-chamber with as little friction as possible, I have arranged the outlet-ports in the stationary or fixed heads or plates, so that the piston is balanced as regards end-pressure in the piston-chamber between two opposed or equalizing pressures exerted against its ends or end surfaces.

235 To understand the working of the device it must be borne in mind that the fluid has free access to the chamber—that is, its inlet-ports are never entirely closed; that because of the shape of the wall of the chamber and of the piston the piston is kept in contact with the wall of the chamber at a number of what I call "contact lines," which form the changing limits of measuring and discharging passages, spaces, or recesses. The number of lines of contact depends, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary, because a full head is maintained in the larger part of the chamber, and it is of course necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by fluid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes, in connection with the portions of the wall which constitute or form the spaces or recesses, also act to separate the outlet-ports from the inlet-ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact-lines—one between the outer surface of the lobe and the wall of the recess and the other between the surface of the inward projection of the wall and the surface of the piston between the lobes. These lines of contact continually advance until the fluid has been expelled from each space or recess.

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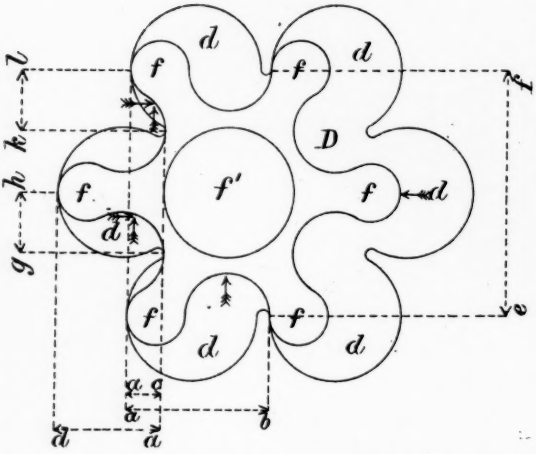
WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886

Fig. 19.



a---b = 1.5
a---c = .35
a---d = 1.1
2.95
.15
Rotative effect 4.425 sq. in.

e---f = 2.6 × 1.5 = 3.90
g---h = .65
k---l = .65
1.30 × 1.5 = 1.95
Contact pressure 1.95 sq. in.

WITNESSES.
[illegible]
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p. 233.

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Fig. 16.

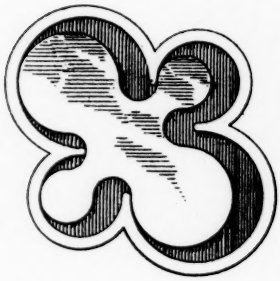

Fig. 17.

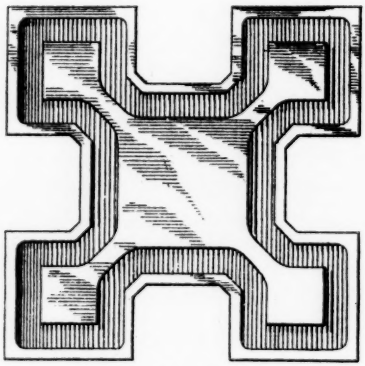

Fig. 18.

WITNESSES.

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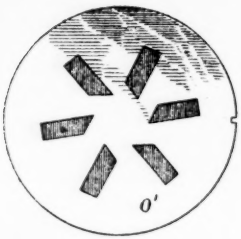

Fig. 13.

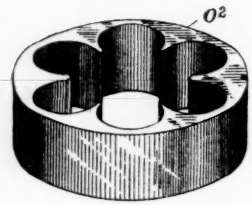

Fig. 14.

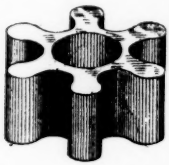

Fig. 15.

Fig. 22.

WITNESSES

[illegible] Wagner and 2d

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p. 231.

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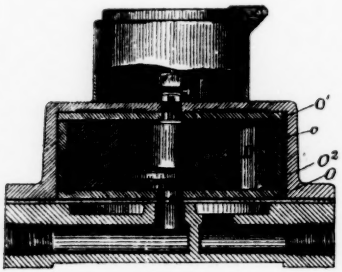

Fig. 9.

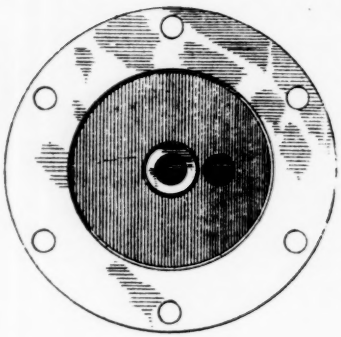

Fig. 10

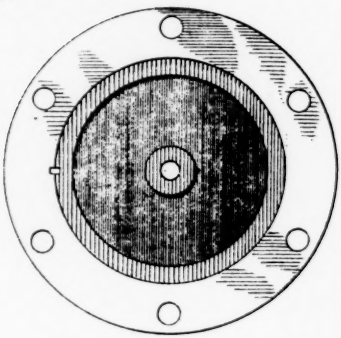

Fig. 11.

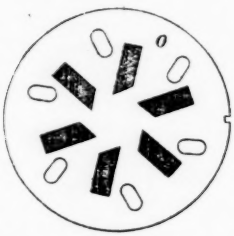

Fig. 12.

WITNESSES.

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Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

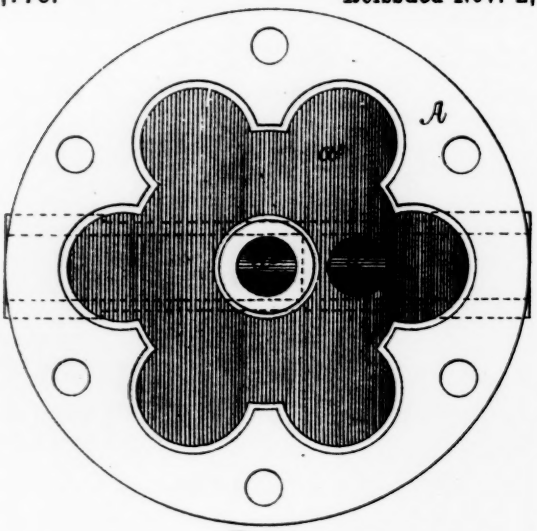

Fig. 7.

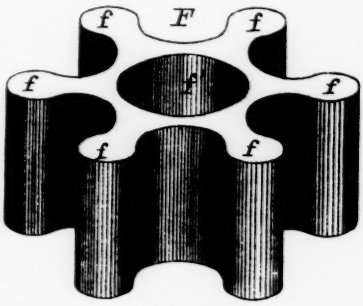

Fig. 8.

WITNESSES

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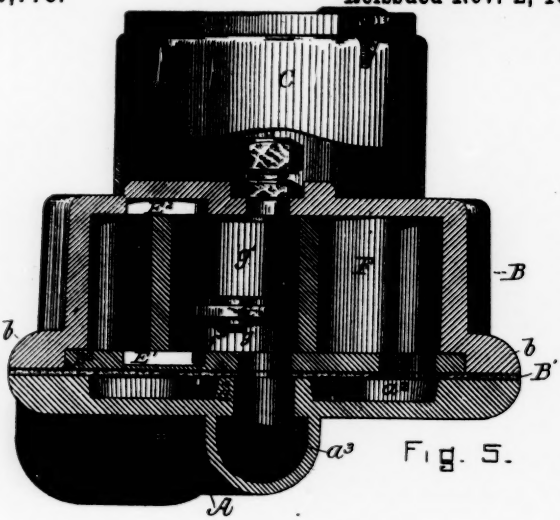

Fig. 5.

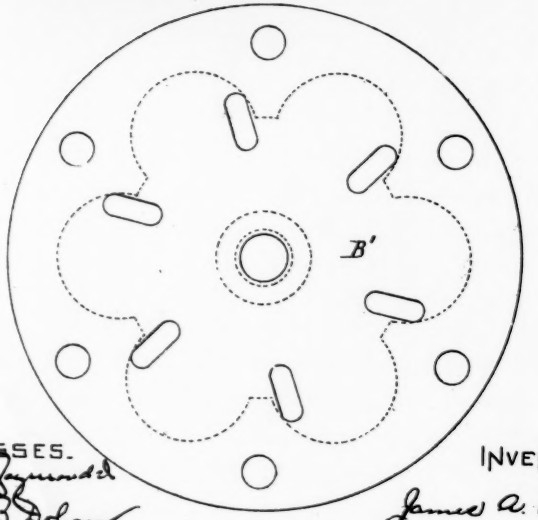

Fig. 6.

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Fig. 20.

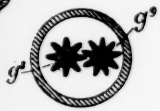

Fig. 21.

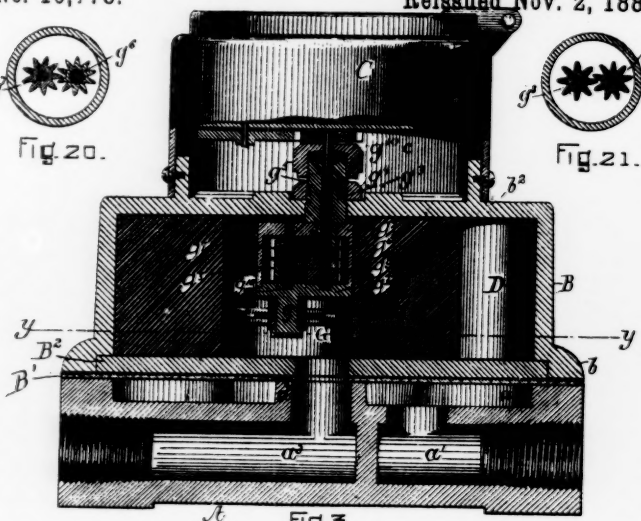

Fig. 3.

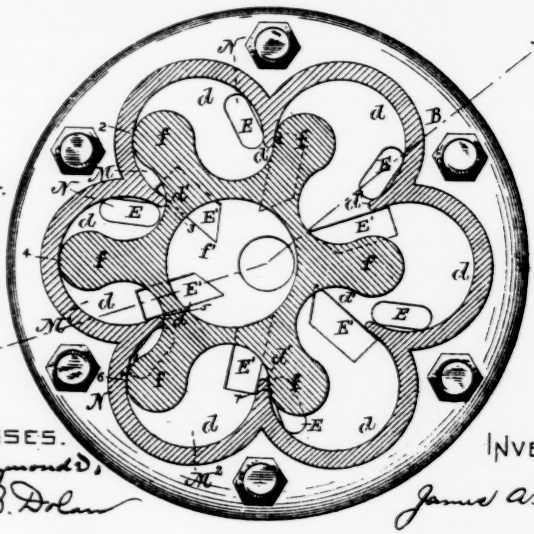

Fig. 4.

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WATER METER WITH REVOLVING PISTONS.

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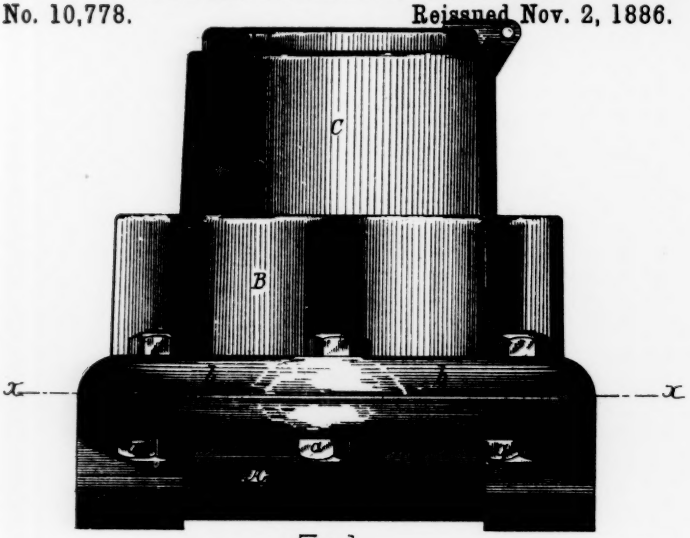
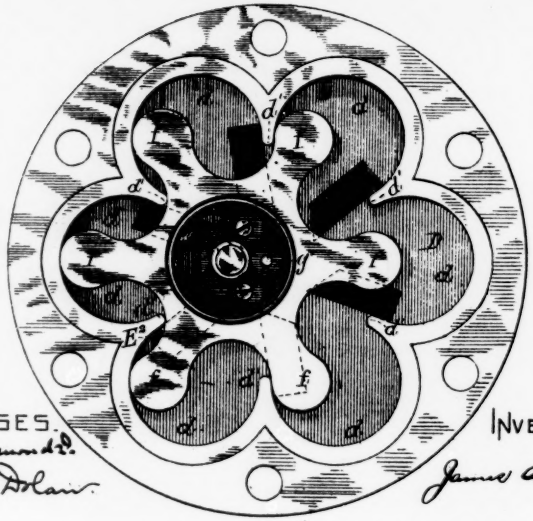


Fig. 1.

Fig. 2



WITNESSES.
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While, however, this discharge from each space or recess is going on by the movement of the lobe, the space or recess is filling behind the lobe. Of course the number of spaces or recesses which are discharging simultaneously depends upon the entire number of spaces or recesses which the chamber contains, and there may be several recesses or spaces discharging and receiving at the same time. This advancing movement of the lobe in each space or recess does not continue beyond its individual space, but upon reaching the end of that space or recess it returns across the mouth or entrance of its recess or space to its original position, while the piston as a whole, without rotating on or about its axis, moves on a circular path.

The contact-lines of the piston, in the operation of dividing the chamber into measuring spaces or recesses and discharging the same, are always upon the same side of the piston, and these contacting lines are brought successively into operation, not by rotation of the piston, but by the successive reverse movements of the lobes, so that the piston, while appearing like a rotating piston, is in principle like a reciprocating piston, in that each of its lobes or projections is caused to enter a measuring space or recess, advance therein, empty it, and return to its original position, to again advance in the said space or recess and empty. In making this movement the contact between each lobe and the wall is not maintained during the reverse movement of each lobe or projection. The piston in other respects has more of the principle of a reciprocating piston than of a rotating piston, in that each lobe or projection operates as a separate or distinct piston or discharging device in connection with its respective space or recess, so that, the recess or space being filled with liquid, the lobe enters it and presses the liquid therefrom through the outlet-ports. In other words, each lobe or projection does not act to displace the liquid from the spaces or recesses like a plunger, but to discharge the liquid therefrom by an advancing movement from one end of the chamber or recess to the other, like a piston.

In the drawings—

(Here follow diagrams marked pp. 226, 227, 228, 229, 230, 231, 232, & 233.)

Figure 1 represents a side elevation of the machine. Fig. 2 is a plan view of a portion of the meter above the line $x\ x$ of Fig. 1, inverted, showing the piston and upper series of outlet-ports. Fig. 3 is a view, principally in vertical central section, showing, especially, the mechanism for connecting the piston with the registering-train. Fig. 4 is a section upon the line $y\ y$ of Fig. 3, also showing the lower series of outlet-ports and the inlet-ports. Fig. 5 is a view, principally in vertical section upon the lines $z\ z$ of Fig. 4, showing, especially, the relation of the outlet-ports, meter-walls, and spaces or recesses when discharging. Fig. 6 is a plan view of the packing-piece between the base and main sections of the meter. Fig. 7 is a plan view of the base-section, showing the receiving-chamber and the inlet and outlet passages. Fig.

8 is a perspective view of the piston. Figs. 9 to 15, inclusive, illustrate special details of a modified form of construction. Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction. Fig. 19 is a diagram showing by calculation the differences in pressure which cause the action of the meter. Figs. 20 and 21 are sections of the reducing-gears hereinafter described, and Fig. 22 is a view of the sleeve forming the support of the drum carrying the gears.

Preferably the casing of the meter comprises three principal parts or sections: first, the base-section A; second, the body or main section B, and, third, the shell C, forming the chamber *c*, containing the registering mechanism.

The base-section is made somewhat larger in circumference than the main section, and the two parts are fastened together by bolts *a*, which pass through the flange *b* of the main section. The base-section has the inlet-passage a', which opens into the distributing-chamber a^2 and the outlet-passage a^3. The distributing-chamber a^2 occupies almost the entire upper portion of the base, and its object is to provide means for the ready distribution of fluid simultaneously through the various inlet-ports to the main chamber D.

Between the sections A B is a packing-piece, B′, which is shaped as shown in Fig. 6, and is provided with holes for bolt-holes,
236 the inlet-ports, and outlet-passages. Above this packing is a metal plate or head, B^2, which may be called a "port-plate." It rests upon the packing B′, and is held or fastened in place upon it and the upper surface of section A, surrounding the chamber a^2 and the central projection, a^4, by the bolts *a*, the plate being within the main section B, and its edge projecting into a recess formed in the under edge thereof. This port-plate has the holes E, which form the inlet-ports to the chamber D and connect the distributing-chamber a^2 therewith. These ports E are arranged, preferably, to open into each space or recess *d* of the chamber D at one side thereof. The port-plate also has a central hole, which forms a portion of the outlet a^3 and the outlet-ports E′, which are recesses formed in the upper surface of the plate, and arranged to extend from one side of each recess or space *d* inward upon converging lines. The chamber D has the measuring recesses or spaces *d* arranged about its outer edge, which open into the central portion, and the projections or portions of the wall of the chamber which form spaces or recesses I have lettered *d*′. The piston F preferably is made of hard vulcanized india-rubber, gutta-percha, or other equivalent material, and has the wings or lobes *f*, which extend radially therefrom. The central hole, *f*′, of the piston forms a part of the outlet passage, and is large enough to always permit the escape of fluid therefrom into the outlet a^3, regardless of the position of the piston.

In addition to the lower set of outlet-ports, E′, I have formed in the under surface of the head or upper plate, b^2, which forms the top of the main section B, another set of outlet-ports, E^2. (Shown in Figs. 2 and 5.) They are of the same shape and connect the same parts of

the spaces or recesses with the opening f' as the lower exhaust-ports, E'.

It will be seen that each measuring space or recess is connected with the outlet-passage by two outlet-ports E' E^2, formed by depressions or recesses in the plates or heads B^2 b^2, and arranged so that the fluid in the measuring-spaces escapes between the port plates or heads and the ends of the piston. It will be seen, further, that if one set only of outlet ports were employed the pressure of the fluid upon one end of the piston would be less than that exerted against the other end, and the piston would be pressed against the head or plate having the outlet-ports, and the resulting friction would interfere with the advantageous working of the piston. To obviate this friction I make use of opposed outlet-ports arranged at opposite ends of the piston, or in the opposite stationary heads of the fixed case, which results in bringing equal balancing pressures upon the piston ends, thus balancing and floating the piston endwise between two opposed fluid-pressures of equal force. There is also arranged in the hole f' a perforated disk, G, (see Figs. 2 and 3,) by which motion is communicated to the shaft which operates the train of gears comprising the registering mechanism. This disk carries at its center a stud, g, which projects downward from the drum g', which is pivoted at g^2 to the screw-sleeve g^3, which passes through the hole in the plate b^2, and is locked thereto by the nut g^4, which screws upon the thread g^5, and the movement of the piston causes the drum to be revolved upon the sleeve. It is necessary, however, as the chamber is of small capacity, and as the motion of the piston is rapid, to reduce the motion of the piston very considerably; and it is desirable to do so in as simple a manner and with as few parts as possible, in order that the construction may be cheap and as little weight of metal used as possible, and I employ for this purpose a train of four gears, one of which, g^6, is stationary, being secured to the end of the sleeve g^3. The gears g^7 g^8 are attached to the drum by the shaft g^{10}, to which they are fastened, and the gear g^7 meshes with the gear g^6. The gear g^8 is arranged to mesh with the fourth gear, g^9, which is fastened to the spindle g^{10}, which communicates motion to the registering-train. As the drum revolves about the sleeve g^3, it is obvious that if the gear g^7 has more or less teeth than the gear g^6 it will be caused to move each revolution of the drum a certain portion of a revolution, depending upon the difference in the number of teeth between the two gears. It is also obvious that if the gears g^8 g^9 have the same number of teeth as the gear g^7, a movement of rotation will be communicated to the shaft or spindle g^{10}.

If it is desired to still further reduce or change the rate of the rotation of the shaft g^{10}, then the gear g^8 may have more or less teeth than the gear g^7, as the case may be, as also may the gear g^9; and in the drawings I have represented the gear g^6 as provided with ten teeth, the gear g^7 with nine teeth, the gear g^8 with eight teeth, and the gear g^9 with nine teeth, so that upon every complete revolution of the drum the shaft g^{10} is moved one eighty-first of a revolution, and it therefore requires eighty-one revolutions of the drum to make one complete

revolution of the shaft, the spindle or shaft g^{10} being used, of course, to operate any registering mechanism.

It will be seen by this construction of gearing that the drum g', carrying the gears g^7 g^8, revolves from left to right, and that the gear-wheels g^7 g^8, being carried by the drum, are caused by the meshing of the gear g^7 with the stationary gear g^6 to turn from right to left, and that the meshing of the gear g^8 as it is turned upon its revolution about the gear g^9 causes the gear g^9 to be moved, as above specified, one eighty-first of a revolution for each revolution of the drum and the gears g^7 g^8 about it.

It will be observed that by making the mechanism for reducing the movement of the piston in compact form I am enabled to place it in the measuring-chamber and within the hole formed in the piston, thereby economizing space.

237 In operation the liquid passes into the distribution-chamber a^2 and through the inlet-ports E into the chamber D, moving the piston toward one side of the chamber, and causing the formation of measuring or discharge spaces by the contact of the various portions of the piston with the chamber-wall. This position of the piston is well shown in Fig. 4, where there have been formed six divisions of the three spaces or recesses d by the contacting of the piston at the points 1, 2, 3, 4, 5, 6, and 7, and of these three recesses or spaces, two—namely, the small spaces marked M and the space M′—are connected by the discharge-ports E′ E′ E^2 E^2 with the escape-passage, while the space M^2 is about to be; but the fluid, upon being admitted to the chamber under pressure, not only immediately moves the piston to the position shown in Fig. 4, which is one of any number of positions which it might cause it to assume, and from such position it causes it to advance or move, so that the lobes which are in contact with the wall of the chamber are caused to continue that contact until they have expelled all the fluid which is in the discharge spaces or recesses before them, when each lobe in succession will leave the surface and return upon an arc of a circle to a position where it again comes in contact with the surface of the wall of the chamber on the opposite side from that which it left, and again advances and expels the fluid from its recess or space.

It will be seen that each recess or space becomes in succession a discharge space or recess, and that as soon as the piston has moved sufficiently to uncover the inner end of its outlet-ports it begins to discharge through such ports into the escape-passages a^3, and that while a portion of each space or recess is discharging another portion is also receiving the liquid under pressure through the ports E.

To illustrate why with the arrangement of the inlet and outlet ports described the piston is compelled to make the motion that it does, I have shown in Fig. 19 by diagrams the differences in pressure upon both sides of the piston and the extent of the surface which is subjected to the direct pressure of the entering fluid.

It is obvious that the chamber D, excepting the spaces which are discharging, is filled with fluid under pressure, and that the pressure for moving the pistons is that which enters each space or recess

which is being discharged, and behind the respective discharging-lobe-. For instance, referring to Fig. 4, the piston is receiving motion from the fluid which enters the spaces through the ports marked N N N, but from no other. It is not necessary that the main chamber and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses, from three upward, and that they may be of any size and of different sizes for the same piston, the only difference to be observed being that the piston and chamber-wall must be so shaped as to provide the contact-lines in the surface of the piston or chamber-wall, whereby the formation of measuring-chambers is effected.

In Fig. 16 I have illustrated a piston having three lobes in a chamber having three measuring and discharge spaces or recesses. In Fig. 17 I have shown a piston with two large lobes and two small ones, and a chamber with corresponding recesses or spaces. In Fig. 18 I have represented the piston as having square lobes, and the chamber with spaces which substantially follow the shape of the lobes, the only variation being that they are rounded at the corners.

It will be obvious from what I have stated that the meter is very simple in construction; that it has but very few parts, which require but little machine-work and are easily fitted and put together; and it is also apparent that a substantially-perfect registration of the liquid which passes through the meter is obtained, as it all is obliged to pass into the measuring-spaces, which are successively emptied. It will be seen, further, that this measuring of the liquid takes place very rapidly, and with the minimum of friction of the wearing parts, and that the construction of the piston and chamber is such that sediment cannot interfere with the proper working of the invention, and that wear, up to a certain extent, improves the efficiency of the meter, in that it causes the contacting surfaces of the piston and chamber to fit themselves as they wear.

To still further cheapen the manufacture I show in Figs. 9 to 15, inclusive, a construction which enables me to use, instead of the comparatively expensive casing of composition, an iron casing. This I accomplish by making the base-section entirely of iron, employing two composition port-plates, O O′, the plate O being like that described, and the plate O′ having simply the exhaust-passages E^2. The piston is made of hard rubber, gutta-percha, or other like non-corrosive material, and the wall O^2 (see Fig. 14) of the chamber D is formed of a ring or sleeve of gutta-percha, hard india-rubber, or even of composition, which is fitted into the iron shell or casing of the main section. This non-corrosive movable wall of the chamber is fastened to the casing by means of a key, *o*, which enters a groove in the ring and a corresponding one in the inner surface of the iron shell, or in any other suitable way. A view in perspective of the movable wall is shown in Fig. 14.

It will be seen that by this construction not only can an iron shell be employed, but that the principal wearing parts—namely, the port-plates, the piston, and the wall of the chamber—may be easily removed and others substituted therefor. The port-plates are

also held in place by suitable keys or in any other desirable way, and it will be observed that they extend upon the two end surfaces of the removable wall. (See Fig. 9.)

While the invention as shown in the drawings represents a
238 piston which, while not rotating moves in a circular path, yet by changing the forms of the piston-lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, elliptical or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston the principle of its action is not changed, as the lobe or portion of the piston which penetrates the measuring-space will have a continuous movement in said space, whether its path be circular, square, rectangular, elliptical, or of any other shape. In this construction the piston in motion is held in changing lines of contact with the internal irregular surface of the fixed case by hydraulic action, as illustrated by the diagram, Fig. 19, and the calculation there noted, so that, while the piston is controlled in its movement by contact with the fixed case, it is free to depart from such contact, being held thereto only by fluid-pressure, and not by mechanical means—such as cranks, links, abutments, &c.—and so can move over obstructions interposing between the irregular peripheral surface of the piston and the opposed surface of the fixed case without causing the piston to jam and cease motion and without risk of breakage or of strain of any part.

Of course the invention can be utilized as a pump or motor, if desired.

Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. A fluid-meter having a stationary piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, and having a movable piston fitted, as described, in said chamber, with lobes conforming to the chamber-recesses, each lobe entering and moving in but one recess, and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, and having parallel stationary heads or plates, whereby end-pressure on the piston is relieved and weight of the moving parts is reduced, substantially as set forth.

2. A fluid-meter having a stationary piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, and having a movable piston fitted, as described, in said chamber, with lobes conforming to the chamber-recesses, each lobe entering and moving in but one recess, and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, and having the opposed arrangement of the ports, whereby balanced valvular action is effected, substantially as set forth.

3. A fluid-meter having a stationary piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, a movable piston fitted, as described, in said

chamber, with lobes conforming to the chamber-recesses, each lobe entering and moving in but one recess, and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, parallel stationary heads or plates, whereby the weight of the piston is reduced and end-pressure thereon is relieved, and an opposed arrangement of the ports, whereby balanced valvular action is effected, substantially as described.

4. In a fluid-meter, the piston-chamber having measuring recesses or spaces forming a part thereof, a piston, F, having a projection or lobe entering each of said spaces or recesses, which projections or lobes are adapted to be brought successively into contact with the walls of said spaces or recesses, and to be moved therein, and the contact maintained during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, a register, and devices connecting the piston with the register, all substantially as and for the purposes set forth.

5. In a fluid-meter, the piston-chamber having measuring spaces or recesses forming a part thereof, the stationary port-plate B^2, a distributing-chamber having an inlet, a', the passages or inlet-ports E in the said stationary port-plate B^2, connecting the distributing-chamber with the measuring spaces or recesses of the piston-chamber, and a piston having a separate or distinct lobe or projection which enters each of said measuring spaces or recesses and is operated or moved and its contact maintained by the excess of pressure, as herein set forth, all substantially as and for the purposes described.

6. In a fluid-meter, the combination of the distributing-chamber a^2, its inlet a', the piston-chamber D, having measuring recesses or spaces d, the uncontrolled ports or passages E, connecting the distributing-chamber a^2 with the recesses or spaces d, the outlet-ports E' E^2 and escape-passages connected therewith, and the piston F, having the lobes or projections f, one for each of the measuring spaces or recesses d, and operated or moved therein to maintain contact during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, all substantially as described.

7. In a fluid-meter, the independent or separate base-section containing the inlet-passage a', the distributing-chamber a^2, and the outlet-passage a^3, with the independent or separate section B, containing the piston-chamber D, having the measuring recesses or spaces d, connected with the distributing-chamber and outlet-passage, as described, and the piston F, having a lobe or projection for each of said spaces or recesses, and the bolts for fastening the two sections of the meter together, all substantially as and for the purposes described.

239 8. The combination of the section A, having the distributing-chamber a^2, the section B, and the removable port-plate B^2, having the inlet-ports E and outlet-ports E'.

9. In a meter, the combination of the section A, having the dis-

tributing-chamber a^2, the section B, containing the measuring-chamber, the port-plate B^2, and the packing-ring B'.

10. In a fluid-meter, as a means for communicating the motion of the piston to the register, the mechanism described, consisting of the stationary gear g^6, the revolving gears g^7 g^8, adapted to be revolved around the stationary gear by the piston, and the gear g^9 upon the connecting-spindle.

11. The combination of the piston F, the disk G, the drum or frame g^2, pivoted, as described, to be revolved, and the differential gears inclosed within said drum or case.

12. The combination, in a fluid-meter, of the piston-chamber D, the piston F, the reducing mechanism or gearing for transmitting the motion of the piston to the registering device contained in a recess in the piston, and the registering mechanism, all substantially as and for the purposes described.

13. A fluid-meter having a piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, and having a piston fitted and moving as and for the purpose described, with lobes conforming to the chamber-recesses, and serving alternately and in successive order to valvularly control or open and close the outlets formed in the heads and piston.

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Witnesses:

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Natl Meter Co
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(No Model.) 4 Sheets—Sheet 4.

J. A. TILDEN.

WATER METER WITH REVOLVING NON ROTATING PISTON.

No. 357,159. Patented Feb. 1, 1887.

Fig. 7

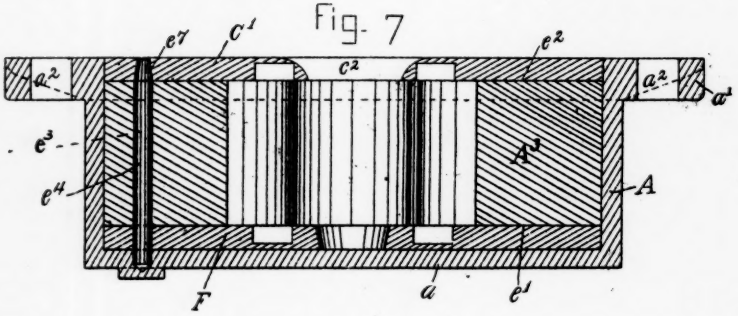
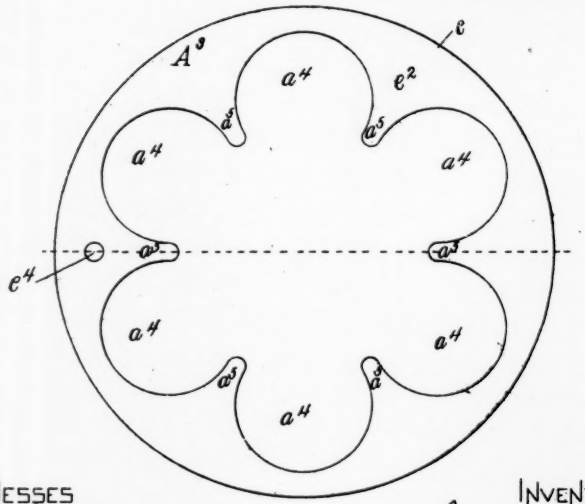


Fig. 8



WITNESSES
J. Frank Charnock
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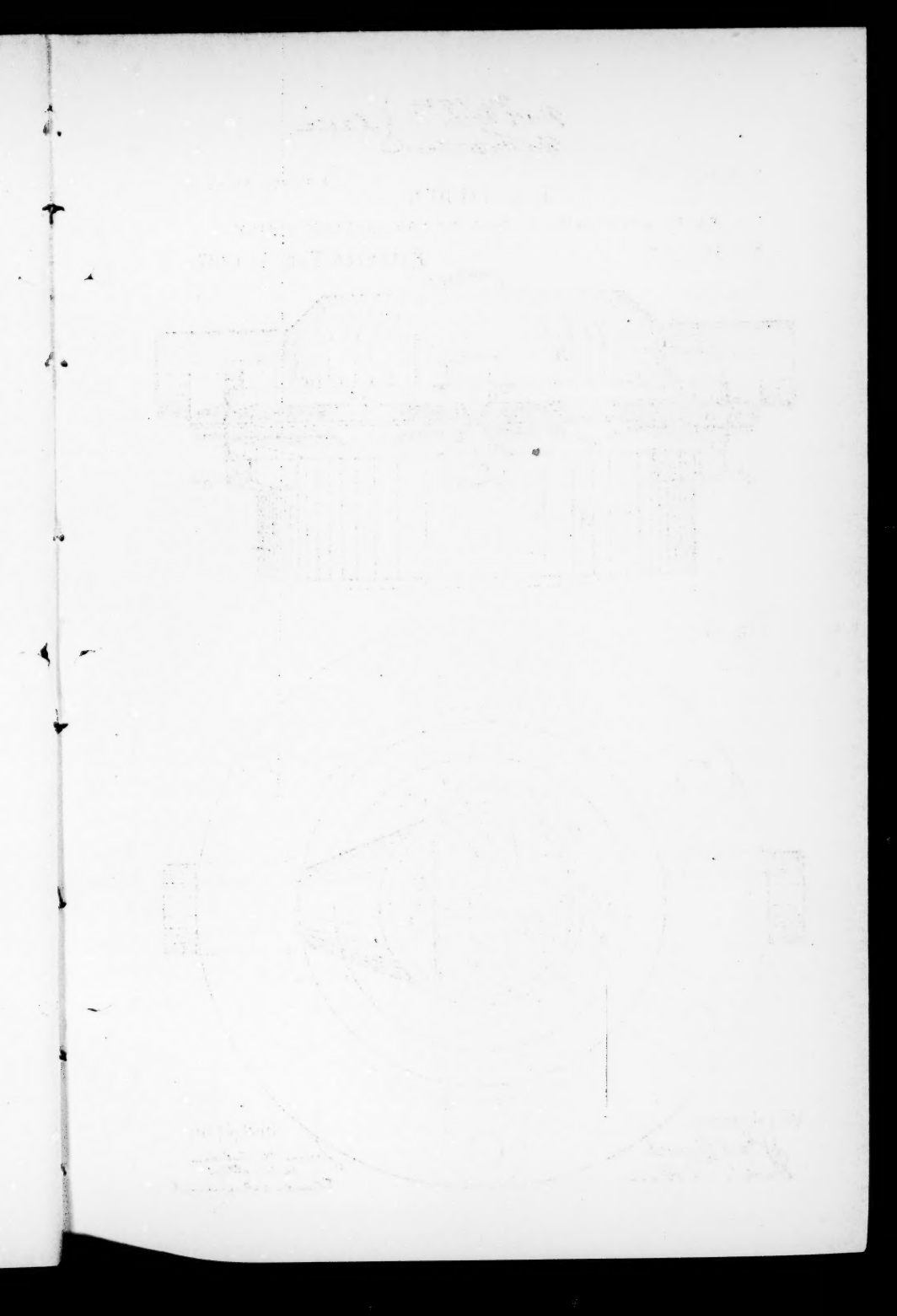

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(No Model.) 4 Sheets—Sheet 3.

J. A. TILDEN.

WATER METER WITH REVOLVING NON ROTATING PISTON.

No. 357,159. Patented Feb. 1, 1887.

Fig. 5

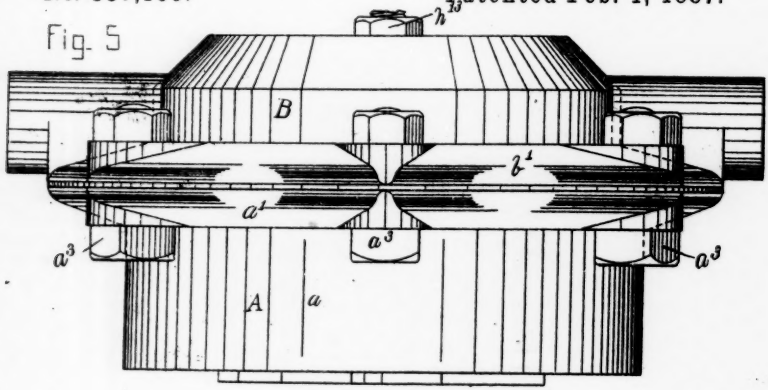
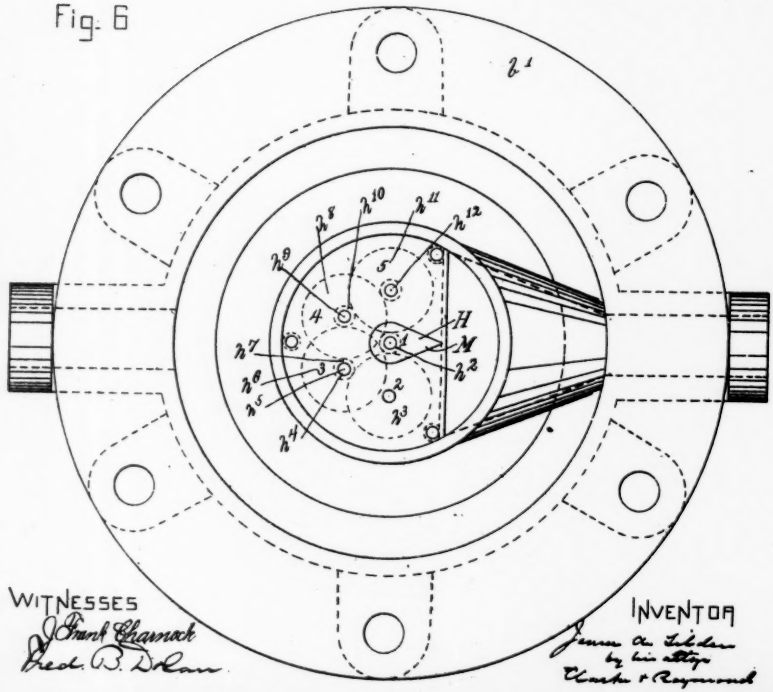


Fig. 6



WITNESSES
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Fred. B. Dolan

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(No Model.) 4 Sheets—Sheet 2.

J. A. TILDEN.

WATER METER WITH REVOLVING NON ROTATING PISTON.

No. 357,159. Patented Feb. 1, 1887.

Fig. 3

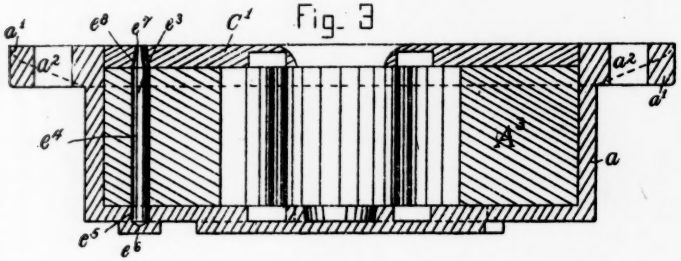
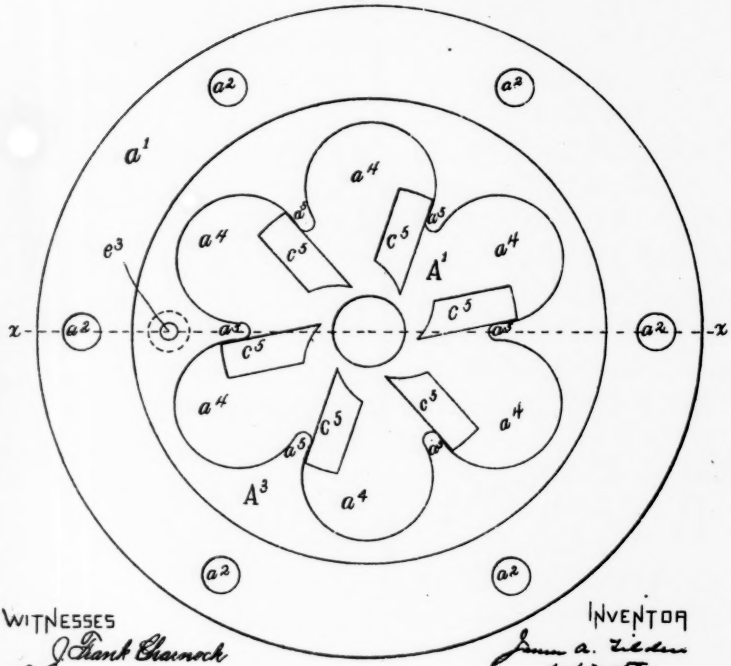


Fig. 4



WITNESSES

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No. 192 Natl Meter Co. v. Bd. Water Comrs. } p. 241.

Nat. Meter Co. v. Bd. Water Comrs. } p. 240.

(No Model.) 4 Sheets—Sheet 1.

J. A. TILDEN.

WATER METER WITH REVOLVING NON ROTATING PISTON.

No. 357,159. Patented Feb. 1, 1887.

Fig. 1

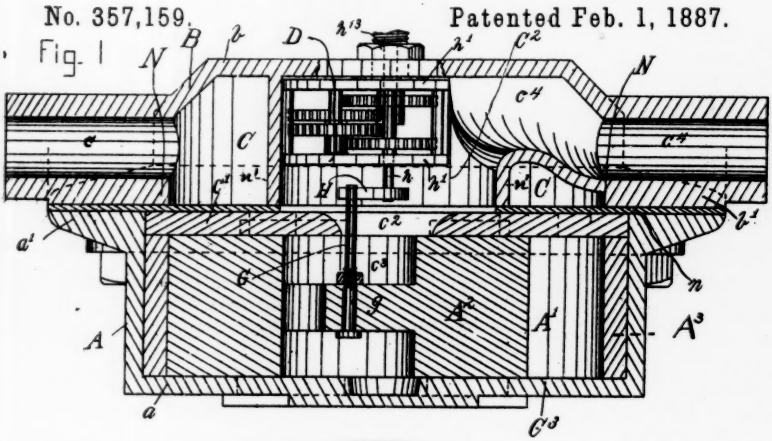
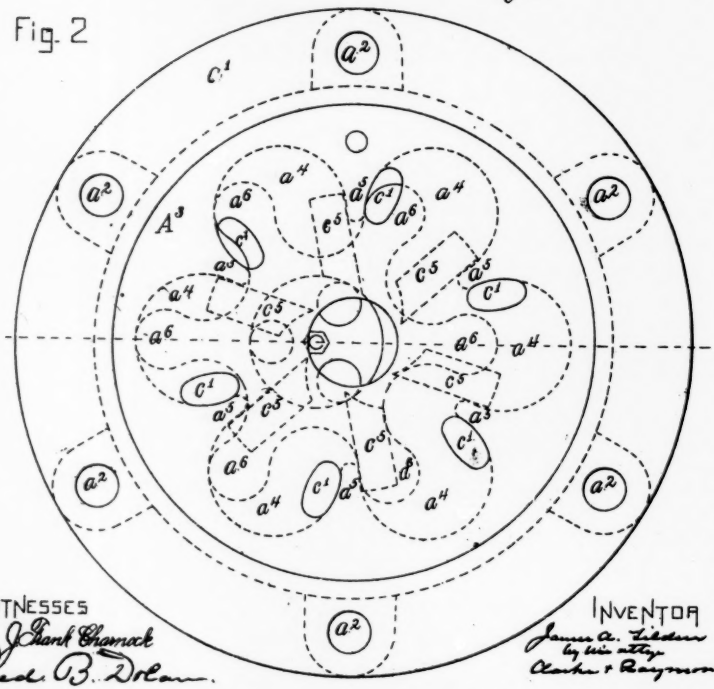


Fig. 2



WITNESSES

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INVENTOR

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Charles F. Raymond

244 UNITED STATES PATENT OFFICE.

JAMES A. TILDEN, of Hyde Park, Massachusetts.

Water-Meter with Revolving Non-Rotating Piston.

Specification forming part of Letters Patent No. 357,159, dated February 1, 1887.

Application filed August 15, 1885. Serial No. 174,463. (No model.)

To all whom it may concern:

Be it known that I, JAMES A. TILDEN, of Hyde Park, in the county of Norfolk, in the State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in water-meters, motors, and pumps, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in explaining its nature.

The invention is an improvement upon that described in my letters patent of the United States, No. 324,503, dated August 18, 1885.

It relates, first, to the position of the measuring-chamber in relation to the inlet and outlet and distributing-chamber; second, to forming the measuring-chamber walls of a different material from the casing, whereby increased durability and efficiency are obtained, and, with certain constructions, economy in the manufacture produced; third, to a connection of peculiar shape and operation between the piston-spindle and the shaft of the reducing-gear; and, fourth, to the arrangement of the reducing-gear in the exhaust-passage.

(Here follow diagrams marked pp. 240, 241, 242, & 243.)

Referring to the drawings, Figure 1 represents a vertical central section of the meter. Fig. 2 is a view in plan of the lower section of the casing with the upper port-plate in position, showing in dotted outline the shape of the measuring-chamber, piston, and escape-ports. Fig. 3 is a vertical section of the lower section of the meter, the piston being removed, upon the line *x x* of Fig. 4. Fig. 4 is a plan view of the section represented in Fig. 3, the upper port-plate being removed. Fig. 5 is a view in elevation of the meter-casing. Fig. 6 is an inverted view in plan of the upper section of the meter. Fig. 7 is a view in vertical section of the lower section or part of the meter, representing a modification, hereinafter referred to. Fig. 8 is a view in plan of the wall of the measuring-chamber.

A is the lower section of the meter, and B the upper section. The lower section comprises the shell or casing *a*, having the annular flange *a'*, in which are formed the holes a^2 for the bolts a^3, used in fastening the two sections together. The lower section, A, contains the measuring-chamber A′ and the piston A^2. The chamber is di-

vided into measuring-spaces a^4 by the portions a^5 of the wall, and the piston has the lobes or sections a^6, which enter these measuring-spaces, and they operate in connection with the walls of each space, as described in my said patent.

The section B has the casing b, which is provided with the annular flange b', through which bolt-holes in continuation of those in the flange a' extend. It contains the distributing-chamber C into which the supply passage or inlet c enters, and which is connected with each of the measuring-spaces a^4 by ports c' formed in the port-plate C′. This section also has the chamber C^2, which is of a size sufficient to receive the reducing-gear D, and which is connected with the measuring-chamber by the centrally-arranged passage or opening, c^2, in the port-plate C′, the said passage or opening connecting with the central opening or chamber, c^3, in the piston A^2. The chamber or passage C^2 also has the outlet or escape passage c^4. The measuring-spaces a^4 are connected with the piston-space c^3 and outlet c^2 by the escape-ports c^5, which are formed in the under surface of the port-plate C′ and in the upper surface of the lower plate C^3, and they are shaped and arranged substantially as represented in Figs. 2 and 4, and as described in my said patent.

In order to increase the durability and efficiency of the meter, I have made the section or part A^3, which forms the wall of the measuring-chamber, of a material possessing greater wearing properties and durability than brass, and the material which I prefer to use for this purpose is hard vulcanized rubber or gutta-percha, or rubber compound. In Fig. 8 I have represented a plan view of this wall. It has its outer surface, e, shaped to fit the interior of the casing a, and its lower surface, e', and upper surface, e^2, are parallel. Its inner surface is shaped to provide the measuring-spaces a^4. It is fastened in place by the pin e^3, which extends through a hole, e^4, in the wall, its lower end, e^5, entering the recess e^6 in the casing a, and its upper end, e^7, which is made somewhat tapering, enters the hole e^8 in the port-plate C′. Of course this section or wall can be fastened to the casing a in any desirable way. This wall, when made of vulcanized stock, is molded to shape in suitable molds, and under great pressure.

245 While I have mentioned the wall as made of hard rubber or gutta-percha, or stock containing rubber or gutta-percha, I would say that I do not confine myself to these materials, but may use any other material which shall be their equivalent for the purposes of durability and efficiency.

I would further state that for the purposes of economy the outer casing, a, of the meter may be made of iron and the wall A^3 be made of brass or composition, or of some non-corrodable material. In this event, however, it will be necessary to provide a removable plate, F, of brass or suitable non-corrodable material, which covers the bottom of the casing a, as shown in Fig. 7, and has the lower series of escape-ports, c^5, arranged therein. When this construction is used, the pin c^4 is also used for fastening this plate in place, the pin extending through the hole formed therein, as represented in Fig. 7. I have found it desirable, also, to make the piston A^2 of

hard vulcanized rubber or rubber stock, gutta-percha or gutta-percha stock, or a mixture of both or some equivalent material possessing like durability; and it is, when made of rubber or gutta-percha, molded to shape under great pressure and vulcanized.

The piston supports or carries the centrally-arranged stem or pin, G, which extends upward from the support or diaphragm *g*, which may be integral with the remainder of the piston or be a separate piece carried thereby or attached thereto. This pin extends upward through the passage c^2, its end projecting into the chamber C^2 containing the reducing gear, and arranged to bear against the wedge-shaped arm or piece H, which is shaped in plan as represented in Fig. 6. This wedge-shaped connection is carried at the end of the shaft *h* of the reducing-gear, and upon the movement of the piston the pin or spindle G is caused to describe a circular path, bears against the side of the arm or connection H, revolves it, and gives motion to the reducing-gear and the register. (See Fig. 1.)

The reducing-gear shown comprises the shaft *h*, which has suitable bearings in the frame or casing *h'* and carries the pinion h^2, which meshes with the gear h^3, which in turn engages the pinion h^4 on the shaft h^5, having the gear h^6, and a pinion, h^7, on the shaft h^5 engages with the gear h^8 on the shaft h^9, and a pinion, h^{10}, on the said shaft h^9 engages with the gear h^{11} on the shaft h^{12}, which passes through the stuffing-box h^{13} (see Fig. 1) and operates the registering mechanism.

It will be seen that the connection H has the surface M, against which the spindle or pin G bears or comes in contact, and is tangential to the circle of revolution of the hub, and that if it is in any degree retarded in its revolution it must operate to cause the spindle or pin G to throw outwardly toward its outer end, as this is the line of the least friction; and as it does require, on account of the friction of the parts, a somewhat slight power to move the piece H, it follows that this power is exerted in causing the pin or spindle to ride outwardly, or rather to be maintained in its outermost position in its relation to the center of the shaft *h*, and this action of the parts I have found of benefit in maintaining a close or tight contact between the wall of the piston and that of the measuring-spaces, especially when the water-pressure upon the piston is exceedingly light.

It will be seen that the port-plate C' rests upon the wall A^3 of the measuring-chamber, and that it is held locked in place between it and the shoulder N of the upper section, B; also, that there is interposed between the two sections a packing-ring, *n*, which, of course, has holes formed therein in continuation of the ports *c'*.

The connection H is attached to the shaft *h*, in order to save parts and expense; but, of course, it may be placed upon an independent support to engage with the post or spindle G, if desired.

Of course the shape of the measuring-spaces and of the piston may be varied, as intimated in my application above referred to, and, of course, in this event the shape of the interior surface of the movable or independent wall will be correspondingly changed.

It will be observed that the piece H has another function from

those above described, in that, on account of its shape and location, it prevents the piston from becoming central in the chamber A′, and so holds it or locates it in said chamber that on the admission of pressure thereto the piston, not being centrally located, is immediately forced or brought into contact with the wall of the measuring-chambers. It will also be seen that the packing-ring *n* serves to pack the space between the lower edge of the wall *n′*, which separates the distributing-chamber from the exit-passage, and the port-plate C′.

Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. The combination, in a meter, motor, or pump, of the chamber A′, having the measuring-spaces a^4, the piston A^2, shaped as specified, the post or spindle G, and the rotating connecting device H, having the tangential surface *m*, substantially as and for the purposes described.

2. The combination of the chamber A′, having the measuring-spaces a^4, the piston A^2, shaped as specified, and having the stem or spindle G, the reducing-gear D, its shaft *h*, and the rotating connecting device H, having the tangential surface or edge M, against which the spindle or pin G bears while it is rotating, all substantially as described.

3. The combination, in a water-meter, of the piston-chamber, the loose piston A^2, held and moved in contact with the walls of the piston-chamber by hydraulic action only, as specified, and a
246 device or stop for preventing the piston from taking a central position in the said piston-chamber when it is not in operation, substantially as described.

4. A fluid-meter having a piston-chamber and a loose piston maintained in contact with the walls of said chamber and confined in its path during operation by hydraulic action, as specified, and a register connected with the piston by an arm or connecting device, substantially as described, which is adapted to transmit the movement of the piston to the register and at the same time, by the friction or retardation of the register, to assist in maintaining the contact of the loose piston with the walls of the chamber, substantially as described.

JAMES A. TILDEN.

In presence of—
F. F. RAYMOND, 2D.
FRED. B. DOLAN.

250 UNITED STATES PATENT OFFICE.

JAMES A. TILDEN, of Hyde Park, Massachusetts, assignor to the Hersey Meter Company, of Portland, Maine.

Rotary Fluid-Meter.

Specification forming part of Letters Patent No. 385,970, dated July 10, 1888; application filed January 25, 1887. Serial No. 225,480. (No model.)

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid-meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in explaining its nature.

This invention relates to an improvement in fluid-meters. In my improvement I employ a piston adapted to have an eccentric or side rocking motion across the cylinder-chamber to effect its division at two or more parts into receiving and discharging spaces. In order to diametrically divide the cylinder-chamber into receiving and discharging spaces, and to maintain a constant division during the continual changing of the piston, the relative shape of the piston and cylinder is such that a constantly-changing point of contact is secured as a bearing upon which the piston rocks. In all forms of meters of this class so far constructed the relative shape of the piston and cylinder-chamber has been such that the several contact-bearings in performing their function brought at each rocking-point such a division of the cylinder as to cause the piston to be rigidly confined in its movement upon these points. It will be readily understood that in this construction the lodgment of the slightest particle of material—such as sand, pipe-scale, or other substance contained in water—will thoroughly wedge and lock the piston, and under heavy pressures of water breakage of the piston will occur. It is to overcome the defect existing in this class of meters that my invention is intended, and to accomplish this result I adapt the piston to the cylinder in such a manner that it is free or confined upon its contact-points by hydraulic action instead of by actual mechanical confinement. The adaptation of this feature to the class of meters in which a piston having projecting lobes conforming to corresponding recesses in the cylinder-chamber and moving only in their corresponding recesses is fully set forth in my reissue patent No. 10778, November 2, 1886. It is the application of this feature to the class of meters in which a piston rocks upon continually-changing points or lines of contact with the cylinder-chamber, and in which the alternating projections and recesses upon the piston are less in number than in the cylinder, that constitutes my invention.

Referring to the drawings—

(Here follow diagrams marked pp. 247, 248, and 249.)

Figure 1 represents an elevation of a meter containing my improvement. Fig. 2 is a plan of the same on the lines *y y* of Fig. 1, showing the piston in section on the lines *z z*. Fig. 3 represents another form of piston and ring, in which are a larger number of contact bearing-points upon which the piston rocks. Fig. 4 represents a similar form having curved surfaces on the piston and ring. Fig. 5 is a diagram illustrating the parallelogram of forces as applied in the operation of the meter. Fig. 6 is a detail of the piston and ring, showing the application of the parallelogram of forces as acting upon the piston in the form contained in my invention. Fig. 7 is a detail of a piston and ring, showing a diagram of forces as acting upon a piston of a form used in the prior state of the art.

A, Figs. 1 and 2, forms the inclosing-case for the piston, the same being provided with alternate projections and recesses, and having an inlet-passage, G, for conducting the water to the center of the case.

B is the cover which incloses the parts, and which forms a chamber for the water which has passed through the measuring-spaces, and from which it is conducted by the outlet-passage H. The case A is formed in such a manner that there are six projections, h' h^2 h^3 h^4 h^5 h^6, having between them six recesses. The bottom of the case is provided with conducting passages or ports extending from openings in each recess to a corresponding opening in the center of the case surrounding the inlet-passage, said ports being divided by walls or divisions *i i i i i i*. This arrangement of ports or passages is such that they are governed in the inlet and outlet of the water by the valve, which also forms the operating-piston. The piston D is made of hard rubber, having five projections, c' c^2 c^3 c^4 c^5, and five corresponding recesses, which are of such a form that a
251 plane passing through from the end of one projection to the side of the one opposite will divide the cylinder-case at *n n*. The inlet-passage G and cavity E conduct the water to three of the port openings in the center of the case, f' f^2 f^3. These ports conduct the water to corresponding openings, e' e^2 e^3—that on the right of *n n* being open to the inlet and that on the left of *n n* being open to the outlet. By referring to Figs. 1 and 2 the outlet-passages and their method of operation will be understood. In the piston is an annular space, *o*, which has communication through holes drilled in it to the open space F in the center of the upper side of the piston represented by the dotted lines. When the ports f^4 f^5 f^6 are open to the annular space, the water is conducted from the outlet-division of the case through the openings e^4 e^5 e^6 to openings f^4 f^5 f^6 through the holes in the annular space to the cavity F and chamber formed by the cover to the outlet-passage H. This system of porting is duplicated in a plate on the top of the piston, which incloses the piston in the cylinder-chamber, so that a balanced action of the piston is obtained. By referring again to Fig. 2, it will be seen that

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(No Model.) 3 Sheets—Sheet 1.

J. A. TILDEN.

ROTARY FLUID METER.

No. 385,970. Patented July 10, 1888.

Fig. 1.

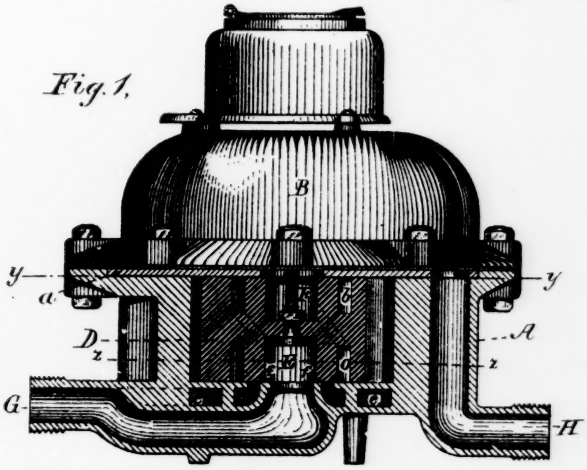
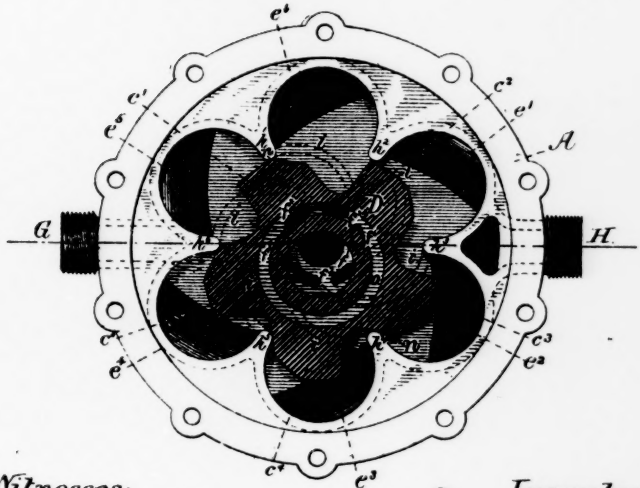


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

J. A. TILDEN.

ROTARY FLUID METER.

No. 385,970. Patented July 10, 1888.

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v.
Bd. Water
Comrs.
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Fig. 3.

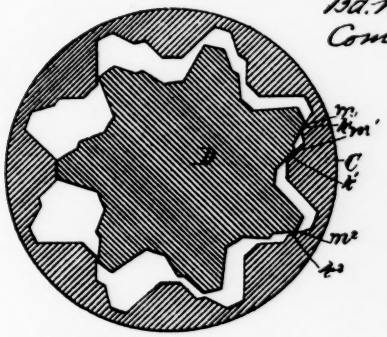

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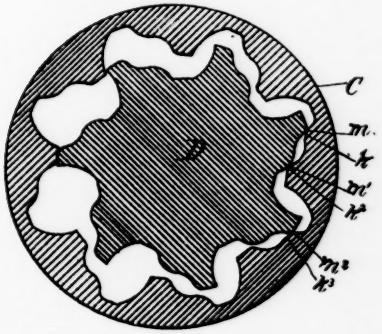
Fig. 4.



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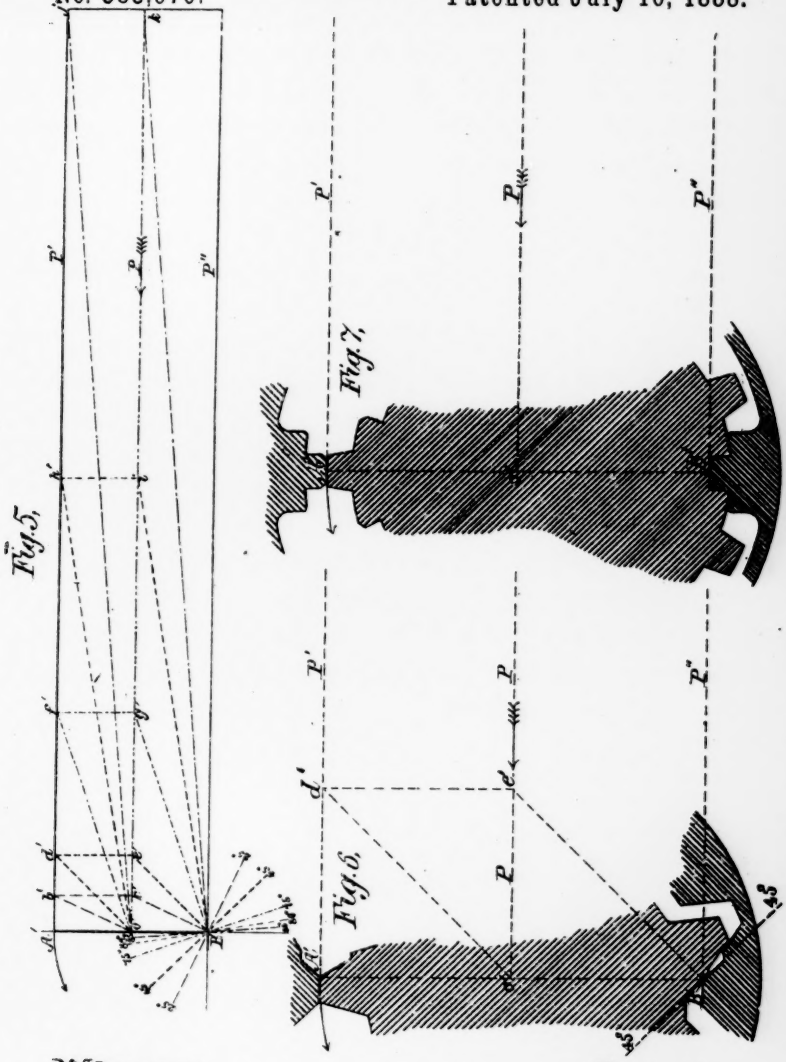
v
Bdwater Comrs

(No Model.) 3 Sheets—Sheet 3.

J. A. TILDEN.

ROTARY FLUID METER.

No. 385,970. Patented July 10, 1888.



Witnesses:
J. M. Dolan.
Fred. B. Dolan.

Inventor.
James A. Tilden.
by his attys Clarke & Raymond.

in the position of the piston as shown, and with the action of the pressures as shown, when water is drawn from the outlet chamber, the excess pressure upon one side of the piston acts to rock the piston successively upon the points or projections *n*.

It will be observed that the form or edge of the piston at *n* does not confine the piston, but that it is free to slide or push out of place should anything get between the opposite abutment, and that it entirely depends upon the action of the water to cause it to work over the point *n* and upon the pressure of the water to maintain the division of the case.

It will be seen that the piston is entirely free for a considerable space, it being limited only by the depth of the recess in the piston. This can be governed in any construction to the size of the port; or, in other words, it can be formed so as to allow all the sliding motion or freedom that is necessary to pass any substance that the ports will admit into the meter.

I do not limit myself to the precise form here shown, as the form will depend to some extent upon the number of projections upon the piston and to the shape and manner of forming the cylinder-chamber.

To accomplish the object of my invention, it is necessary to form the projections relatively upon the piston and cylinder-chamber in such a manner that the point of contact upon which the piston rocks shall be behind the direction of rotation, and in such a manner that there shall be no shoulder upon the piston to confine the rocking-point, but that the rocking-point will at all times be maintained by the direct action of the water.

It will be readily seen that this invention consists in the relative formation of the piston and cylinder-chamber in such a manner that the piston is in no way confined in its division of the case into separate chambers by a strictly mechanical path, but that the proper division of the case into supply and exhaust chambers depends entirely upon the hydraulic action, it being governed by the system of ports so arranged as to properly dispose the water in the measuring parts. By means of this invention the defects heretofore contained in this class of meters are wholly done away with—that is, the liability of its being stopped or locked by any foreign substance getting into the working parts of the meter; and, further, that it is self-compensating in its wear—that is, all contact-points of the piston and cylinder-chamber wear alike, and the piston is free to follow up this wear and still maintain its form to properly operate, while in other forms, where the piston is confined in its path of movement, the lines of division will be shortened by wearing the ends of the piston projections, and allow the water to leak or pass unregistered.

To still further illustrate the scope of my invention, I will describe certain peculiarities in relation to the bearing-points over which the piston rocks.

An inspection of Figs. 3 and 4 and diagrams 5 and 6 will show angular rocking-points, by which there is a wedging effect sufficient to produce contact in the operation of the piston between the rocking-point B, Fig. 5, and abutment A. This same angular or wedg-

ing effect will be found in Fig. 2; but in these forms of meters there is but one contact-point made by the piston in rotating from one recess into another. In these forms it is evident that a somewhat harsh action takes place in the operation of the meter, owing to the few points of contact made during a rotation of the piston. A preferable form of construction is therefore shown in Figs. 3 and 4. Referring to Fig. 3, it will be seen that in each recess in the cylinder-case are two angles, as indicated in one of the recesses at k and k'. There are also upon corresponding sides of the piston projections two angles. The angles upon the side of the recesses are formed at forty-five degrees to the diametric division made by the piston when it has made its contact-bearing.

It will be seen that when the contact-point m has its bearing on the angular surface k the piston can rock on that point until the second contact-point, m', has a bearing upon the angular surface k', which is at forty-five degrees to the diametric division made by its contact. The piston then rocks on this point until the next contact-point, m^2, has its bearing on the angular surface k^2. This operation continues, forming continuously-changing contact-bearings for the piston to rock upon, each contact-point causing the piston to diametrically divide the case in two chambers.

It will be seen that the relative form of the piston and cylinder-case is such that the contact bearing-points are not mechanically defined, but that they are unconfined for a considerable space, so that the actual contact-bearing will be at a point upon the angular surface governed by the hydraulic action and upon the abut-
252 ment—that is, should anything get between the piston and its abutment on the opposite side the contact-bearing will be made lower on the angular surface, or should the projections on the piston become worn the contact-points will be higher up on the angle; in other words, the piston is free for a considerable space. This space can be governed by the relative formation of the piston and cylinder-case, and can be sufficient to allow the passage of any foreign substance that the meter is liable to admit to its working parts. Other angles than forty-five degrees may be used in the formation of the parts, and should be that most suitable to the operation of the meter, and it will be further considered in the following illustrations. It will be seen that in the construction a larger number of contact bearing-points are presented, and therefore a very easy and smooth operation of the meter is obtained.

Fig. 4 represents a similar construction to Fig. 3, with the exception that curved surfaces are formed upon the piston and cylinder-case instead of angular surfaces.

To clearly demonstrate the precise operation of the meter and the difference of its operation over the forms at present known to the state of the art, I have constructed in Fig. 5 a diagram of the parallelograms of force as applied to this form of meter. By referring to Fig. 5, A′ B′ represent a line of diametric division of the cylinder-case or the operating-piston upon which the hydraulic force P acts. O′ is any point upon the piston at which the force is directed, as indicated by the arrow. If now an angular surface (for instance, that

represented in the dotted lines indicated by twenty-five degrees) is presented to the point B′, and upon which the piston is to rock, swinging by the abutment at A′, and it is desired to know the relative contact and rotative effects in its operation, pressure P (represented by rotative effect *c′ o′*) may by the parallelogram of force be resolved into *c′ b′*, or pressure at right angles to A′ and *c′* B′, or pressure at right angles to B′, (twenty-five degrees.) It will thus be seen that the relative rotative and contact effects are as *c′ o′* to *c′ b′* and *c′ o′* to *c′* B′. As the angular surfaces at B′ are changed, the parallelograms of force become relatively different—that represented by the angle forty-five degrees producing a rotative effect, *e′ o′*, and contact effect *e′ d′*. As the angle approaches ninety degrees to the direction of force, a greater difference of relative effects appears. For instance, at the angle eighty-five degrees there is an excess rotative effect, *k′ o′*, over the contact effect *k′ j′*. When the angle of ninety degrees is reached, the lines of parallelogram disappear, and there is rotative effect wholly and no contact-pressure.

Further reference to the operation of the piston will be understood by referring to Fig. 6, which represents a portion of my improved piston.

It will be seen that the angles upon the cylinder-case are formed here at forty-five degrees, the corresponding angles upon the piston projections being such as to present a contact-point which finds its bearing upon the angular surface, where the bearing is made and during its rocking and until another point of contact is made. This forms the diametric division of the case at A′ B′.

It will be seen that in constructing the parallelogram of force there is an equal division of the pressure effects, pressure P here represented by rotative effect *c′ o′* and contact effect *e′ d′*, the contact-pressure effects being divided into *e′* B′ contact-pressure to maintain the piston against the angle, and *e′ d′* to maintain the piston against the abutment. By this construction it will be readily understood that the piston can be less in diameter than that actually necessary to diametrically divide the case, thereby making it possible to move the piston away from its abutment, and it will return by the action of the water-pressures when the resistance to its contact is removed; and it will be observed by referring to Fig. 7, in which the surface presented is at ninety degrees to the direction of force, there is and must be a perfect mechanical fit to divide the case diametrically, and that the pressure is wholly rotative. It is impossible for the piston to assume any position in the cylinder case other than that which it is confined to by mechanical fit. In my invention there exists a free compensating piston, as clearly shown by the several illustrations, while that shown in Fig. 7 has inherent in its principle a mechanically-confined piston and an uncompensating construction.

It will be seen from the foregoing that it is quite essential to the advantageous working of my improved form of free hydraulically-maintained piston that each projection, both on the piston and casing or chamber, shall have its bearing-surface upon the end and one side only, for if there is a bearing upon both sides of the projection,

after the manner of the tooth of a gear and like the ordinary practice heretofore, there will be a locking and mechanical rigidity which it is the very object of this improvement to do away with. Division-contact thus takes place between opposing end projections on the one side and opposing side surfaces on the other side in distinction to the end contacts on both sides hitherto used or shown. For the best working of the device there are frequently two or more end projections in contact on the same side and two or more side surfaces in contact on the opposite side, as shown. This insures a greater uniformity and ease of action. The angular side bearing-surface may be on either the piston or casing, or on both, but always in
253 such a manner that the piston may be free and have the hydraulic division-contact, as fully set forth.

I do not limit myself to any particular number of contact bearing-points, or points forming diametric divisions of the case by the piston, as the same may be so constructed as to present three or more angular surfaces upon each recess in the side of the cylinder-case, having three or more contact-points upon each piston projection.

I do not in any way claim as my invention the construction of a meter having a piston adapted to have an eccentric or side rocking motion across the cylinder-chamber to effect its division at two or more points into receiving and discharging spaces.

Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. In a water-meter, the combination of a casing forming a piston-chamber and having projections extending into the chamber to form measuring spaces or recesses, each of which projections has a bearing surface at its end, with a piston having a series of projections, each of which has a bearing-surface at its end and an angular bearing-surface upon one side, as and for the purposes described.

2. In a water-meter, the combination of a casing forming a piston-chamber and having projections extending into the chamber to form measuring spaces or recesses, each of which projections has an angular bearing-surface upon one side, with a piston having a series of projections, each of which has an angular bearing-surface upon one side, as and for the purposes described.

3. In a water-meter, the combination of a casing forming a piston-chamber and having projections extending into the chamber to form measuring spaces or recesses, each of which projections has an angular bearing-surface upon one side, with a piston having a series of projections, each of which has a bearing-surface at one end and upon one side, as and for the purposes described.

4. In a fluid-meter, a casing forming a piston-chamber having a series of projections extending into the chamber to provide measuring spaces or recesses, each of which has an angular bearing-surface upon one side, as and for the purposes described.

5. In a fluid-meter, a piston having a series of projections, each of which has an angular bearing-surface upon one side, as and for the purposes described.

6. In a fluid-meter, in combination with suitable inlet and exhaust ports, a ring contained in the meter-case and having projections

from its inner side, and forming, in connection with the port-plates, the piston-chamber, each of which projections has an end bearing-surface and a side bearing-surface, with a rotary piston contained in said chamber, having projections, each of which has an end bearing-surface and a side bearing-surface, and which piston and ring co-operate upon the rotation of the piston to divide the piston-chamber into receiving and discharging spaces by the contact at one point of the end bearing-surfaces of a piston and ring projection, and at another point of a sliding contact between the side bearing-surface of one ring projection and the side bearing-surface of a piston projection, substantially as described.

JAMES A. TILDEN.

In presence of—
F. F. RAYMOND, 2D.
J. M. DOLAN.

254 [British coat of arms.]

A. D. 1843. No. 9744.

Specification of Elijah Galloway.

Propelling vessels.

London: Printed by George E. Eyre and William Spottiswoode, printers to the Queen's Most Excellent Majesty: Published at the Great Seal Patent Office, 25, Southampton buildings, Holborn. 1855.
Price 10*d.*

255 [British coat of arms.]

A. D. 1843. No. 9744.

Propelling Vessels.

Galloway's specification.

To all to whom these presents shall come, I, Elijah Galloway, late of Seymour Street, Euston Square, in the Parish of Saint Pancras, in the County of Middlesex, but now of Union Place, City Road, in the said County, Civil Engineer.

Whereas Her present Majesty Queen Victoria, by Her Letters Patent under the Great Seal of Great Britain, dated at Westminster, the Twenty-fifth day of May last, for Herself, Her heirs and successors, did grant unto me, the said Elijah Galloway, my executors, administrators, and assigns, by myself and themselves, or by my or their deputy or deputies, servants or agents, or such others as I, the said Elijah Galloway, should at any time agree with, and as often from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick-upon-Tweed, and the Islands of Jersey, Guernsey, Alderney, Sark, and Man, and also in all Her Majesty's Colonies and Plantations abroad, my Invention for "Certain Improvements in the Machinery for Propelling Ships and other Vessels;" in which said Letters Patent there is contained a proviso obliging me, the said Elijah Galloway, by an instrument in writing under my hand and seal, particularly to describe and ascertain the nature of my said Invention, and in what manner the same is to be performed, and to cause the same to be inrolled in Her Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said Letters Patent, as in and by the same, reference being thereunto had, will more fully appear.

256 Now know ye, that in compliance with the said proviso, I, the said Elijah Galloway, do hereby describe and ascertain the nature of the said Invention, and in what manner the same is

to be performed, by the Drawings hereunto annexed, and to the numbers and letters of reference marked thereon, that is to say :—

My improvements consist,—First, of improved methods of increasing the rate or velocity of the axes of the propellers beyond that of the axis of the steam engine.

Secondly, of an improved method of raising the propellers out of the water, and lowering them into their place to be attached to the driving axis.

Thirdly, of an improved form or construction of paddle-wheels.

In reference to the improvement comprised under the first head, I must explain that it is requisite in giving motion to screw propellers that their number of revolutions in a given time should be several times greater than that of the axis of a condensing steam engine. Instead of getting such increase of velocity by any of the ordinary methods of multiplying motions, I propose to produce the same by the arrangements illustrated by Figures 1, 2, 3, and 4, which *my* be thus explained :—

(Here follow diagrams marked pp. 261, 262, & 263.)

I must begin by referring to Figure 1, which, though containing some portion of the principle of this arrangement, is here given to illustrate the method of producing the requisite form of a portion of the apparatus rather than the instrument itself which I propose generally to use. *a* and *b* are two toothed wheels (the latter being of the kind commonly known as an internal toothed wheel). Now if these wheels revolved upon axes in the usual way, *a* would make an entire revolution whilst *b* made only some portion of a revolution ; but if *b*, instead of revolving upon an axis, be suspended upon three cranks (*c*, *c*, *c*,) of equal lengths, and the radii of which are respectively equal to one half the difference between the diameters of the two wheels (calculating such diameters from the pitch lines), and if the whole apparatus be at first in the position indicated by the Drawing, then by causing *a* to revolve it will be found that the cranks (*c*, *c*, *c*,) (and consequently their axes,) will make three revolutions during the time that the inner wheel (*a*) makes one revolution. So if the proportionate diameters differ, say as two or three, or four to five, or any other integral proportions, and the lengths of the cranks (*c*, *c*, *c*,) be determined according to the rule I have given, then the cranks will always make as many more revolutions than the axis of *a* as the diameter of the driving wheel (*a*) is to the difference between the diameter of the two wheels. But I propose in most cases, as I have stated, instead of using toothed wheels, to adopt the arrangement shewn at Figures 2, 3, and 4, which I shall now explain.

257 Let it be supposed that three equidistant points (*d*, *d*, *d*, Figure 1,) could trace their path upon a plate or disc attached to *b*, and moving therewith ; such path would be four epicycloids dotted thereon ; and if to the points *d*, *d*, *d*, three rollers of equal diameter were affixed, then a figure *e*, *e*, *e*, *e*, Figure 2, would be the tangent of the said rollers in every part of their path, or, in other words, the rollers would trace out the figure *e*, *e*, *e*, *e*, Figure 2. Such

being the case, it will be manifest that, instead of toothed wheels, we adopt the arrangement shewn at Figure 2, where *d*, *d*, *d*, are the three rollers affixed to arms and revolving in bearings, and the figure *e*, *e*, *e*, *e*, whose interior curve aperture is generated upon the principle I have explained, then, on motion being given to the main axis, the cranks dotted at *c*, *c*, *c*, will make three revolutions for one of the main axis; and if the figure *e*, *e*, *e*, *e*, be accurately constructed, and the cranks truly proportioned, the action of the machine will be comparatively smooth and noiseless. In like manner, if the circles or wheels *a* and *b* be in their diameters as two to three, the figure *f*, *f*, *f*, Figure 3, would be generated; and by attaching the two rollers to the axis, as there shewn, the velocity of the main axis would be to the crank axes as two to one. Or if the diameters of *a* and *b* be as four and five, the figure *g*, *g*, *g*, Figure 4, would be generated; and by constructing the apparatus as shewn at Figure 4, the relative velocities of the main axis and crank axes will be as 4 to 1.

I would further observe, that in whatever proportion the multiplication be effected, it is necessary that the number of the rollers and of the epicycloids should be respectively equal to the number of times the generating circles can be divided by the difference between the two diameters. It will also be manifest that the multiplication effected by this method does not admit of fractional quantities, but must always be in integral proportions. I must further explain, that if one propeller only is intended to be used, one only of the three crank axes must be prolonged for that purpose; but if two propellers are intended to be applied, then two of the crank axes should be similarly prolonged. It is further necessary to explain that the arrangement of this contrivance may be changed by attaching the driving axis to the epicycloidal figure, and the cranks to the part to which the rollers are attached, in which case the proportion of the multiplication will be also changed, so that the cranks of Figure 2 would make three revolutions instead of two, those of Figure 3 would make four revolutions instead of three, and those of Figure 4 would make five revolutions instead of four.

And further, under the improvements contemplated by the first head, I propose, when straps or bands are used for the purpose of multiplying the motion of the screw axis, to adopt the following means for preventing such straps or bands from slipping upon their respective drums or riggers; that is to say, I propose to pierce the periphery of the drums with a number of small holes, into which are to be secured or driven a number of minute steel pins, their points outward, and radiating from the axis. Those pins must be from an eighth to a quarter of an inch above the surface and have very fine points. I propose also to line the bands or belts with some woven or plaited texture, similar, for instance, to the fabric used for horse-girths. This fabric should rather exceed in thickness the projecting length of the steel pins, and must be served throughout to the belt or strap itself. It will be evident, therefore, that on motion being given to the drums these pins will be forced into the fabric lining the belts, and that the tendency to slip will be opposed by each of them holding firmly therein.

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The improvements comprised under the second head are represented by Figures 5 and 6, and are thus explained:—Figure 5 is an isometrical perspective view of the after part of a vessel, with one of the propellers, (for this improvement is only conveniently applicable where two propellers are used,) in place and connected with the driving axis; and Figure 6 is a horizontal section of the bearings and screw. *h*, *i*, are two bearing frames firmly affixed to the vessel; *j* is the screw axis; and *w* is the screw (which may either be of the form known by the name of the Archimedean screw, or any other propeller whose motion through the water is helical or spiral; *k* is a bow capable of turning freely on the axis, as will be seen by the section. To the enlarged ends of this bow there are attached two chains *l*, *l*, *will* pass through the apertures *m*, *m*, in the bearing frame, and thence through a hawse pipe (*n*), and so on to the capstan of the vessel or any other suitable purchase, observing that the said pipe shall be carried internally high enough above the water-line to avoid an influx of water. At the after end of the screw axis there is a collar *o*, to which is attached the shackle and chain *p*, the collar being sufficiently loose on the axis to allow it to revolve freely therein. The driving axis *q* is capable of being projected from or drawn into the interior, and its outer end is square or polygonal, fitting into the recess *r* of the screw axis, thus forming a coupling, so that when the axis *q* is turned the screw must necessarily turn therewith. The axis passes through a suitable stuffing-box, and when projected from within has a short intermediate piece inserted between it and the preceeding length to form the coupling complete, all which will be readily understood by engineers.

The machinery being in place as shewn at Figure 5, I will proceed to explain the method of detaching the propeller, and raising it out of the water. The intermediate length in the interior being first removed, then, by heaving on the chains *l*, *l*, the shaft *q*,
259 together with the bow and screws, will all be drawn forward until the after end of the axis is clear of the after bearing *s*, and rests upon the horns *t*. The after chain *p* is then wound up, so as to raise the propeller to about an angle of forty-five degrees. The two forward chains *l*, *l*, are then slackened out, and the after chain wound up as nearly uniformly as possible, so as to keep the screw axis in a state of tension, and thereby prevent it shaking or rocking about in a sea way; and this operation is thus continued until the end of the shaft is close up to the davit *u*, in which position the screw may be further secured. To replace the screw this operation must obviously be merely reversed, being first lowered by heaving upon the chains *l*, *l*, until the ends of the bow *k* rest upon the mouth-like cavities of *m*, *m*. The after chain is slackened out until the after end of the axis falls into and rests between the horns *t*. The shaft *q* is then pushed outwards until it is coupled to the screw axis, and until the after end of the said axis is inserted into the after bearing *s*, when the whole is ready to be set in motion by the engine.

And further, Figures 7 and 8 represent my improved paddle-wheel, which I shall next describe. It is well known that steam

vessels, when fitted with paddle-wheels, and deeply laden, cause such wheels to be inconveniently immersed in the water, and thereby to retard the motion of the engines, and consequently that of the vessel. To reduce the loss from this cause I propose to construct the paddle-wheels (especially those intended for long voyages and of varying cargoes) as shewn in Figures 7 and 8. The wheel consists of four sets of arms and rims; two, *r* 1, *r* 1, fixed to the shaft, and two fixed to the hollow axis *s* 1, *s* 1. It will be apparent, therefore, that by moving the hollow axis *s* 1, *s* 1, all the parts attached thereto, namely, the rims and arms and the paddles *t i*, *t i*, shewn by the parts tinted blue in the Figures 7 and 8, may be either closed, so as to assume the position shewn at Figure 8, or expanded to the position of Figure 7, or may be placed in any intermediate position. To effect this adjustment there are two screws *u* 1, *u* 1, connected by wheels *v* 1, which cause the two screws to move simultaneously, so that by turning the wheels *v i* the screws cause the paddle-wheel to expand and contract at pleasure.

Having now described the nature of my said Invention, and the manner in which the same is to be performed, I hereby declare that I lay no claim to any part of the machinery herein described, excepting the parts or portions comprised under the following descriptions; namely,—

Firstly, I claim as my Invention the improved method of increasing the velocity of the propellers or propeller beyond that of the engine shaft represented by Figures 1, 2, 3, and 4, and herein-before described.

260 Secondly, I claim the method herein described of preventing bands or straps from slipping on the drums or riggers.

Thirdly, I claim the arrangement or combination of instruments for raising and lowering, and of attaching and detaching screw propellers, shewn at Figures 5 and 6.

And, fourthly, I claim the method of adjusting paddle-wheels herein described.

In witness whereof, I, the said Elijah Galloway, have hereunto set my hand and seal, the Twenty-third day of November, in the year of our Lord One thousand eight hundred and forty-three.

ELIJAH (L. S.) GALLOWAY.

SENIOR. And be it remembered, that on the Twenty-third day of November, in the seventh year of the reign of Her Majesty Queen Victoria, the said Elijah Galloway came before our said Lady the Queen in her Chancery, and acknowledged the Instrument aforesaid, and all and every thing therein contained and specified, in form above written. And also the Instrument aforesaid was stamped according to the tenor of the Statute made in the fifty-fifth year of the reign of His late Majesty King George the Third.

Inrolled the twenty-third day of November, One thousand eight hundred and forty-three.

London: Printed by George Edward Eyre and William Spottiswoode, Printers to the Queen's most Excellent Majesty. 1855.

264 (Second edition.)

[British coat of arms.]

A. D. 1846. No. 11,485.

Specification of Elijah Galloway.

Rotary and Locomotive Engines, and Railways.

London: Published and sold at the Patent Office Sale Branch, 38, Cursitor Street, Chancery Lane, E. C. 1886.
Price, 1*s.* 1*d.*

265 (Second edition.)

A. D. 1846. No. 11,485.

Rotary and Locomotive Engines, and Railways.

Galloway's specification.

To all to whom these presents shall come I Elijah Galloway of 14 Buckingham Street Strand Civil Engineer send greeting.

Whereas Her present most Excellent Majesty Queen Victoria by Her Royal Letters Patent under the Great Seal of the United Kingdom of Great Britain and Ireland bearing date at Westminster the Fourteenth day of December One thousand eight hundred and forty-six in the tenth year of Her reign did for Herself Her heirs and successors give and grant unto me the said Elijah Galloway my ex'ors adm'ors and assigns Her especial licence full power sole privilege and authority that I the said Elijah Galloway my ex'ors adm'ors and assigns or such others as I the said Elijah Galloway my ex'ors adm'ors or assigns should at any time agree with and no others from time to time and at all times during the term of years therein expressed should and lawfully might make use exercise and vend within England Wales and the Town of Berwick-upon-Tweed my Invention of "Improvements in Rotary Engines and in Locomotive Engines and in Railways" in which said Letters Patent is contained a proviso that I the said Elijah Galloway shall cause a particular description of the nature of my said Invention and in what manner the same is to be performed by an instrument in writing under my hand and seal to be inrolled in Her said Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in part recited Letters Patent as in and by the same reference being thereunto had will more fully and at large appear.

Now know ye that in compliance with the said proviso I the said Elijah Galloway do hereby describe the nature of my said
266 Invention and the manner in which the same is to be performed reference being had to the Drawings hereunto annexed and to the figures and letters of reference marked thereon it

being understood that similar letters indicate similar parts of the machinery represented by the Figures.

(Here follow diagrams marked pp. 270, 271, 272, 273, & 274.)

My Invention as regards the rotary engine is represented by the Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, & 13, but in order to explain the principle thereof I will begin by referring to the Figures 1 and 2 but firstly to Figure 1.

The figure here represented consists of segments of circles constructed by striking them from points in the polygonal dotted figure *a, b a b* the centres *a* being at the angles of the polygon and the centres *b* at intermediate points between the angles *a*. These centres being determined, it is required to construct the blue and red figures so that the space between the figures should be parallel. This is done by striking two concentric segments from each of the centres *a* and *b* the junction taking place in the dotted lines of the polygon. Having explained the method of constructing the figures let us suppose the red figure cut out of a flat piece of metal of some substance and uniform thickness and the blue one to be shaped in a similar piece of metal that is to say, the red figure represents the external form of the inner piece of metal and the blue figure a recess or aperture. This being done if we insert a pin into the centre of the inner figure and describe therewith the dotted circle *c* (Figure 2) beginning by placing the parts as shewn at Figure 2 we shall find that there will be several points of the two figures in contact with each other in every part of the movement produced by describing the circle *c* and if the pieces be truly formed several of the intermediate spaces as *d e f g* (caused by the contact of the segments) will be found successively to be enlarging or contracting during the movement of the inner piece. If we now conceive the pieces to be enclosed between flat surfaces fitting accurately it will be seen that any fluid contained in cavity *d* could not get into cavity *e* nor that in *f* into cavity *g* and it will be found that in whatever part of the circle *c* the centre of the inner piece be placed if it be pressed outwards there will be several insulated cavities like *d e f* and *g*. Now let us suppose steam be admitted by some suitable arrangement so as to be entering into the cavities *e* and *g* and that the cavities *d* and *f* have a passage open to the atmosphere it would follow that the inner piece which I shall henceforth call the piston would have a tendency to move in the direction of the arrows (Figure 2). If now we conceive that the pin of a crank whose radius is equal to that of the dotted circle be inserted in a suitable hole in the centre of the piston by arrangements hereafter to be explained the piston
267 would turn the crank round in the direction of the arrow.

By this motion enlarging and diminishing cavities would successively result and we have only to conceive that steam be supplied to the enlarging cavities at proper intervals and that the diminishing cavities be successively opened to the atmosphere or to a condenser and it will be readily conceived how a rotary motion will be communicated to the axis of the crank referred to.

I now proceed to describe the practical construction of an engine embodying the principle here described the axis of which is here supposed to work in a vertical position.

Figures 5 and 6 are horizontal and vertical sections of the engine and Figures 7, 8, 9, 10, 11, 12, & 13 are various views of the parts thereof. *l l* is an external case in which the working parts are enclosed. *m* is the piston and *n* the receiver which performs the office of the cylinder of an ordinary engine. These parts the general form of which will be seen by referring to the various Figures are constructed of the form shewn in Figure 1 being of the same shape for their entire depth. This form is given to them before the end plates *o* and *p* are attached to them and may be obtained by a shaping machine or other known means and perfect contact will be ensured by subsequent grinding. The flat plates *o* and *p* are bolted to the piston and receiver respectively and when working the end contact of the surfaces is secured by the lower surface (*m*. 1) of Figure 8 rubbing on on the upper surface (*p*. 1) of the lower plate *p* while the under side of the plate *o* rubs on the upper surface (*n*. 1) of the receiver. The receiver is fitted into the case by its upper flange forming a metal joint *q q* therewith and securely bolted thereto. The crank *r* has a groove along the outer edge of its pin into which a segmental piece *s* Figure 10, is fitted and forced outward by a spring lying in the bottom of the groove all which will be readily understood by referring to the Drawings. The crank pin is as it will be seen inserted in a corresponding hole in the piston (see Figures 5, 6) and is somewhat smaller than the hole in the piston and the object of the spring is to ensure the necessary contact between the segmental surfaces of the piston and those of the cylinder or receiver. It will now be readily comprehended that if steam be admitted by the steam pipe *t* through the cover *u* which carries the crank (Figure 6) it would fill the space above the piston but could not get to the eduction passage *v* without passing through the engine that is to say the space above the piston is charged with steam while the space between the case and receiver are open to the education passage. To effect the proper admission and emission of the steam there are five holes *w w w w w* through the plate *o* as seen in the plan views of the piston (Figure 8). The centre of these holes
268 must be on the lines forming the polygon (Figure 1) and just touch the points of junction between the segments forming the piston. There are also five similar holes *x, x, x, x, x*, through the upper plate of the receiver. It will be seen that no steam can escape to the eduction pipe except through the holes *x x*. To regulate the eduction there are five grooves *y, y, y, y, y*, cut or recessed in the under or working side of the upper plate *o* of the piston and it will be manifest on a little examination that the piston on performing its circuit will bring the curved part of each of the grooves or recesses *y* successively over its particular hole *x* and thus open channels of communication for a period between each diminishing cavity and the eduction passage by the curved portion of the recess passing over the hole *x*. Referring to Figure 2 therefore it will be seen that the cavity (*z*) is just about to become insulated from the induction

way and that at about the same time instant the curved groove coming over the hole *x* of that compartment allows the inclosed steam in *z* to escape and the communication thus formed will continue open until the cavity *z* is closed up by the onward motion of the piston all which will be understood by well considering Figure 2 and its principle of action.

Figures 3 and 4 represent other modifications of the same principle of generating the segments Figure 3 having flat ends to the three piston arms. In all cases the essential property depends on the making the space between the piston and receiver parallel which is secured by the uniform expansion of the outer figure or receiver whatever may be the form and size of the inner one.

I shall now proceed to describe the improvements in locomotive engines secured to me by the present Letters Patent and it is necessary to state that on or about the Eighteenth day of April 1846 I obtained Letters Patent for improvements in locomotive engines in which I proposed to propel locomotive engines by the use of horizontal driving wheels being pressed towards each other by means of springs such wheels acting simultaneously on a middle rail laid midway between the ordinary rails of a railway and what I am now about to describe is proposed to be used as a modification of that principle that is to say instead of the horizontal position of the driving wheels described and shewn by the Specification of that Patent I now propose to incline the wheels at an angle as shewn in the Diagram Figure 14. The object of this modification is to keep more clear of the ground than the horizontal wheel permits and that there should be less liability to come in contact with snow or articles left or falling on or near the line and lastly the object is that the arrangement will be more convenient for crossings switches and turnsout.

Figure 14 represents the inclined wheels which however do not require description as regards the springs and adjustment as
269 excepting the inclining of the wheels the details will be much the same as those of my Patent of April 1846, referred to, and to the Specification of which I generally refer.

And lastly in reference to my improvement in railways comprised in this patent I hereby declare such improvement to consist in making the working faces of my middle rail Figure 14 of steel by having thin layers of steel welded on the surfaces on which the nipping or biting wheels act. This can be done by piling or uniting thereon bars of steel at a welding heat or by some one of the usual methods followed when iron is covered with steel such processes being well known to iron manufacturers.

Having thus described the nature of my Invention and the manner of performing the same I would have it understood that I do not confine myself to the details as herein described so long as the peculiar character of either part of my invention be retained. But what I claim is

First the mode of constructing rotary engines herein described.

Secondly I claim the application of inclined wheels as driving

wheels of locomotive engines such wheels being pressed towards each other and against a rail as herein described and

Thirdly I claim the applying steel to the side surfaces of a central rail against which driving wheels press as described.

In witness whereof I the said Elijah Galloway have hereunto set my hand and seal this Fourteenth day of June in the year of our Lord One thousand eight hundred and forty-seven.

ELIJAH (L. S.) GALLOWAY.

RUSSELL.

And be it remembered that on the Fourteenth day of June in the year of our Lord 1847 the aforesaid Elijah Galloway came before our said Lady the Queen in Her Chancery and acknowledged the Specification aforesaid and all and everything there in contained and specified in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute made for that purpose.

Enrolled the Fourteenth day of June in the year of our Lord One thousand eight hundred and forty-seven.

London: Printed by Eyre and Spottiswoode, Printers to the Queen's most Excellent Majesty. For Her Majesty's Stationery Office.

275 Circuit Court of the United States, Southern District of New York.

NATIONAL METER COMPANY
vs.
THE BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS. } In Equity.

It is hereby stipulated and agreed by and between counsel for the respective parties that Wilmarth H. Thurston may act as special examiner to take testimony in the above-entitled case within the District of Rhode Island under and pursuant to the 67th rule of the Supreme Court of the United States, in equity, as amended.

BROADNAX & BULL,
Sol'rs for Compl't.
LIVERMORE & FISH,
Sol'rs for Def't.

276 Circuit Court of the United States, Southern District of New York.

NATIONAL METER COMPANY
vs.
THE BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS. } In Equity.

Evidence for Defendant,

Taken pursuant to the sixty-seventh rule of the Supreme Court of the United States, in equity, as amended, before me, Wilmarth H. Thurston, special examiner.

PROVIDENCE, *July 19th*, 1888.

Present: J. E. Bull, Esq., of counsel for complainant; F. P. Fish, Esq., of counsel for defendant.

Deposition of Henry B. Renwick.

Direct examination by Mr. FISH:

Int. 1. What is your name, age, residence, and profession?

277 A. Henry B. Renwick; age, 70; I reside in the city of New York, and am by profession a civil and mechanical engineer.

Int. 2. What experience have you had in matters pertaining to machinery and as an expert in patent causes? State also whether or not you have any familiarity with rotary engines, pumps, motors, and water meters and the state of the art relating thereto. If so, how extensive has been your acquaintance with the subjects last referred to?

A. I have been engaged, more or less, in examining, inspecting, and constructing machinery since I left college and for the last fifty years. During the last thirty-five years I have been frequently examined each year as expert in suits in which patents were in question.

I have seen and examined many rotary engines and water meters of various kinds, and, if I remember right, have drawn some patents for water meters. When appointed examiner in the Patent Office in 1847 or 1848, I forget the exact date, I had for some four years and a half the charge of all applications for patents for steam-engines, water meters, and pumps, including those of a rotary character, and have since I left the Patent Office had occasion to examine machines of that class, and was expert in one suit certainly in which rotary meters were involved.

Int. 3. Have you read reissued letters patent of the United States to Lewis H. Nash, No. 10806, dated February 8, 1887, on which this suit is brought, and do you understand the same and the construction and mode of operation of the apparatus and devices therein shown and described?

A. I have frequently read and considered the reissue named in

the question; also a model made in accordance with certain parts thereof, what may be called a skeleton model, and also a working meter, and believe I understand the construction and operation of the meter described in the reissue.

278 Int. 4. Have you examined specimens of the "Hersey meter," so called, represented in this case by "Complainant's Exhibit D," which I now show you, for the use of which meter this suit is brought, and do you understand the construction and mode of operation of the same?

A. I answer yes to both branches of the question.

Int. 5. Have you read the deposition of Henry L. Brevoort on behalf of the complainant in this case?

A. I have.

Counsel for the defendant introduces in evidence a copy of British letters patent to Elijah Galloway, No. 11485 of the year 1846, for rotary and locomotive engines and railways, and the same is marked "Defendant's Exhibit Galloway Patent, W. H. T., spec. ex."

It is agreed by counsel that the copy of said patent introduced in evidence shall be used with the same force and effect as though duly certified, and that uncertified copies of any British or United States letters patent which are introduced in evidence by either party in this case may be used with the same force and effect as though duly certified.

Counsel for defendant also introduces in evidence a copy of reissued letters patent of the United States to H. F. Read, No. 4391, granted May 3, 1871, a copy of United States letters patent to E. Chapman, No. 70802, dated Nov. 12, 1867, and a copy of the letters patent of the United States to Frederick Ortlieb, No. 71208, granted November 19, 1867, and the same are marked respectively

279 "Defendant's Exhibit Read Patent, W. H. T., spec. ex.;" "Defendant's Exhibit Chapman Patent, W. H. T., spec. ex., and Defendant's Exhibit Ortlieb Patent, W. H. T., spec. ex."

Counsel for complainant objects to the introduction of said patents to Read, Chapman, and Ortlieb for any other purpose than as illustrations of the state of the art, and now gives defendant's counsel notice that if he employs said patents as anticipations, or for any other purpose than illustrations of the art, he will, at the hearing, move to strike said exhibits from the record, and this on the ground that the necessary foundation therefor is not laid in the answer.

Defendant's counsel also introduces in evidence a printed book, entitled "The Kinematics of Machinery, by F. Reuleaux, translated and edited by Alexander B. W. Kennedy," and published by McMillan & Co., in London, England, in the year 1876, and the same is marked "Defendant's Exhibit Reuleaux Kinematics, W. H. T., spec. ex."

It is agreed by counsel that said book was printed and published in the year 1876.

Int. 6. Describe the construction and mode of operation of the apparatus which forms the subject-matter of the reissued letters patent to Nash, here in suit, and state what you understand to be

the improvement in water meters which forms the subject-matter of that reissue, making such references to the state of the art as known to you as you may deem necessary.

280 A. Long prior to the invention of Mr. Nash it was well known that steam and water engines, whether rotary or reciprocating, could be used as meters, or to measure the flow of the fluids which passed through them, and various forms of rotary steam-engines and of reciprocating engines had been used as meters. The reissue in suit recognizes this fact. Prior to the invention of Mr. Nash there is described in Reuleaux's Kinematics in evidence several kinds of rotary engines and rotary pumps which might be used as meters, and on page 434 there is described a rotary engine in several forms which has precisely the construction and mode of operation of the piston and cylinder or chamber that are described in the reissue in suit. If a proper disclaimer had been made in the reissue it would have been a declaimer of this engine in Kinematics and not of the engine of the Galloway patent, which operates in a totally different way from that of the reissue; and I may call attention here, before leaving Kinematics, that the piston in the three forms of the engine shown has points and depressions between them less in number than the points and depressions in the enclosing case, against which the points work, and that this is the only construction of piston and cylinder described in the Nash reissue and the only construction in which the piston will have the motions which he describes.

Mr. Nash took this meter of Kinematics and made certain changes in the ports and passages and converted it into a meter, leaving the combined operation of the piston and cylinder the same as it is in Kinematics.

Mr. Nash throughout describes his piston as having one or more less points of projection than the cylinder, and he says: "The compound motion of the piston and the contacting dividing points are due to the fact that the piston has one or more less points of projection than the cylinder."

Now, this is not true of the Galloway disclaimed engine, in which the piston has the same number of points or projections as the cylinder, but is true of the engine in Kinematics.

281 It now becomes necessary to ascertain what this compound motion is, for it is referred to in all the claims that the defendants are said to infringe. The Nash reissue, lines 30, etc., describes the side-rocking motion and then goes on to say as follows: "With this eccentric or side-rocking action the piston also revolves around its own centre, and both these movements are effective by the relative shapes of the piston and cylinder, and by the direct action of the water on the piston, for as the piston rocks from one bearing point to another directly across the centre of the cylinder it is at the same time revolved to effect the measurement of the water passing into and from the cylinder spaces."

This statement that the piston has a rotary movement on its own axis is repeated several times in the patent. I quote, "In the rotation of the piston around its own centre," "side-rocking and rotary

piston;" on page 2, line 85, etc., "To allow of the rotation of the piston not only upon its own axis but around and across the centre of the cylinder;" page 3, line 17, etc., "To produce the compound rotation and cross movement of the piston."

Now, in order to give some idea of what this compound motion of the piston is, namely, a rotation on its own axis, and a side-rocking or eccentric motion, as it is improperly called in the patent, I have had prepared a skeleton model of the plaintiff's meter, which I now produce.

The same is introduced in evidence and marked "Defendant's Exhibit Skeleton Model Nash Meter, W. H. T., spec. ex."

Examination of this model will show that the piston and cylinder are made in accordance with figure 3 of the plaintiff's drawings; that the piston has one point less in number than the containing chamber or cylinder, as described in the patent, and that the
282 piston rocks from one bearing point to another cross the chamber or cylinder, as described in the patent; and, also, that in a certain position, as shown best in figure 12 of the drawings of the patent, when one point of the piston is in a depression of the case or cylinder, the exactly opposite point of the piston rests upon a protuberance of the case, a thing which could not happen unless, as described in the patent as before quoted, the piston had less points of projection than the cylinder. Now, I have had a handle attached to the axis of the piston of this skeleton model. It will be seen by turning this handle that the piston rotates on its own axis, and that in doing this the points of the piston and the handle rock over from side to side as the handle revolves. This is the side-rocking motion set forth in the patent and may be easily traced by moving the piston around slowly. Under the influence of this compound side-rocking and rotary motion each point of the piston revolves all around the axis of the piston, each point of the piston passing in succession over all the points of the cylinder, and each point drawing when in motion precisely the same curve.

I have had prepared a diagram of the plaintiff's meter which shows the curve described by all the points of the piston and now produce it.

Diagram put in evidence and marked "Defendant's Exhibit Diagram of Motion of Points of Plaintiff's Piston, W. H. T., spec. ex."

(Here follows diagram marked p. 283.)

The red line in this diagram is the line which all the points of the piston describe. Each one of the points traces precisely the same single curve, and that curve is very near the curve called in geometry an epicycloid—that is, the curve drawn by any point in the tire of a wheel when the wheel is revolved with its tire rest-
284 ing and traveling upon a cylindrical surface, the variation from a epicycloid being due to the fact that the piston is like a cog wheel working upon a circular rack. Now, whatever may be the meaning of the words "eccentric motion" as loosely used in

conversation, it is certain that in this patent it means the side-rocking motion which I have attempted to describe, and this side-rocking motion causes the points of the piston as they rotate around the axis of the piston to describe the epicycloidal curve represented by red lines in the diagram.

Now, turning to figure 12 of the patent drawings it will be seen that if a line be drawn through two opposite points of the piston all or nearly all of the spaces on the left of that line are discharging water, while all or nearly all of the spaces on the other side of that line are receiving water. Mr. Brevoort says and says truly that at times one or more spaces is neutral—that is, neither receiving or discharging—but all the spaces which do discharge *and* on one side of this line and all the spaces which receive are on the other side. Now, the pressure of the water on the entering side of this line causes the piston to revolve, and that is the only effect of the pressure of the water in this contrivance. It does not tend to keep the piston tight when it wears or to keep two of its points in contact with the cylinder. When the points either of the piston or the cylinder wear in this contrivance the meter will leak and measure incorrectly. I think that Mr. Brevoort in making the opposite assertion is mistaken. In this meter the tightness is secured solely by the size and fit of the parts, piston and cylinder, and not by the pressure of the water. For instance, if in the model produced by Mr. Brevoort, "Complainant's Exhibit E," the skeleton marked 3–12 has the piston put in the position shown in figure 12 of the drawings and the piston be supposed to be shortened by wear, the
285 water will then leak past the contacting points, as the patent calls them.

In order to admit and discharge the water into and from this meter Mr. Nash invented certain ports and passages on and within the piston, which, acting in connection with the heads of the cylinder, work as valves, causing water to be admitted into such closed spaces (by closed spaces I mean spaces closed by contact of th*is* piston points with the cylinder) as may be necessary, while the exit or exhaust from those spaces is shut. These valves also permitted water to flow out of certain spaces while the entrance of water thereinto was closed. In the centre of the piston of the Nash patent meter there are two sets of "passages," as he calls them. By reference to figures 4 and 5 of the drawing these two sets of passages will be seen, one marked e and other e^1. One set of these passages is for the admission of water and the other for the discharge of the water. There are as many admission passages as there are depressions between the points of the piston, and as many exhaust passages as there are depressions between the points of the piston, and it is absolutely necessary that there should be this number, both of admission and discharge passages, and that each passage should be separate and distinct from all the others and be capable of being closed or opened irrespective of the fact whether the others are closed or open. One end of all the exhaust passages passes out through the top of the piston, and one end of all the admission or eduction passages passes out through the bottom of the piston, as

trnown in figures 4, 5, 1, and 2. Now, the patent calls the ends of
nctese passages—that is, where they appear on the upper and lower
surface of the piston—"ports," and it also calls the openings through
the bottom and top of the cylinder J and K, Figs. 1 and 2, "ports."

So there are two kinds of ports spoken of in the patent—first,
286 the openings in the top and bottom of the piston into the pas-
sages which go through the piston, which are all separate and
distinct from each other, and, second, the openings through the upper
and lower heads of the cylinder. Now, if one looks at the skeleton
model of the meter of the Nash reissue, a lot of oval holes will be
seen in both the top and the bottom of the piston, and each of these
openings connect with passages within the piston, which passages
open out into the depressions between the points of the piston, and
it will be seen also that each of these ports and each of these pas-
sages is distinct and separate from all the others. If the skeleton
model be again taken and the seven large holes in the top and in
the bottom brass plates be imagined as shut up, then you will have
the end plates of the cylinder as in an actual meter. These holes
were cut in order to show the motion of the piston points in connec-
tion with the cylinder. When these holes are shut the central hole
in the two brass plates will remain open as they do in the actual
meter. These central holes are bounded by epicycloidal curves, and
these holes are the second so-called ports of the patent. By turning
the piston of this skeleton model round it will be seen that the ports
in the ends of the piston are sometimes under the epicycloidal hole
and sometimes outside of it. Suppose water is entering one of these
epicycloidal holes and is being discharged from the other, the four-
teen holes in the heads being stopped up, as before stated, then when
any port in one end of the piston is within the epicycloidal hole,
water will enter that port and proceed to the space between two
points of the piston, while no water will enter those ports and their
attached passages which are outside of the epicycloidal hole. It will
thus be seen that one head of the cylinder is in fact the induction or
entrance valve, as by means of this head the ports and pas-
287 sages for the entrance of water between the points of the piston
are opened and closed. On the opposite side of the piston
the ports are opened and closed in the same way. Water passes out
of all the ports which are within the boundaries of the epicycloidal
hole, and water is prevented from passing out of all those ports which
are outside of the boundaries of the same hole. Consequently one
head of the piston is the exhaust valve of the meter, as the exhaust
ports are opened and closed by their revolution over that head.
These ports, both for the inlet and discharge of water, one set in one
end and the other set in the other end of the piston, must be so
arranged and shaped substantially with reference to the hole through
the heads of the cylinder, which the patent also calls ports, that all
the inlet ports d on one side of the line Z in Fig. 12 of the patent
shall be open and all the exhaust ports d^1 on that side of the line
closed, while on the other side of the line Z all the exhaust ports d^1
must be opened and all the inlet ports d closed. This line Z con-

tinually revolves during the revolution of the piston, and the port in the piston are opened and closed in succession as this line revolves.

If all the ports and all the passages in the piston are not separate entirely from each other and if they are not so arranged with reference to the ports J K in the two heads of the cylinder that they will open and shut as before stated, this meter will not work at all.

In all rotary water meters, and I have seen descriptions of hundreds of different ones, it is necessary to attach in some way or other to the revolving piston a register or counter similar to those attached to gas meters and steam-engines, which will record the number of revolutions made by the piston. As the meter discharges a certain quantity of water at each revolution of the piston, an inspection of the register will show the number of revolutions, and consequently the amount of water discharged since the register was last
288 inspected. These registers are of various kinds, some of them requiring a rotary and some of them a reciprocating motion to move them.

In the Nash reissue a rotary counter is employed. As the centre of the piston describes a seven-sided figure and not a circle, it is evident that the axis of the piston could not enter the hole in the end of a crank which fitted it and turn the crank and the counter or register shaft which might be attached to that crank, because the hole in the end of the crank would describe a circle, while the pin projecting from the centre of the piston would describe a seven-sided figure. Consequently the pin in the piston, instead of being passed through a hole in the crank, merely bears against the side of the crank and is free to slide along the crank outwards and inwards from the register shaft. As the meter piston always turns in one direction, this device answers the purpose of working the counter. If the pin on the piston entered a slot or long hole in the crank it would serve the same purpose, or the same effect would be produced if the hole in which the pin entered was circular and was sufficiently large to permit the pin to vibrate in it.

Adjourned to Friday, July 20, 1888.

PROVIDENCE, *July* 20, 1888.

Present: Counsel as before.

Int. 7. Mr. Brevoort has testified that while the pistons in all the forms of meter in the Nash reissue have an "eccentric" motion, "the term 'side-rocking' was used as descriptive of those forms," only in which "if a point on the piston be selected it will be
289 found that the point forms small arcs in the movement of the piston," and he says that the forms shown in Figs. 3, 9, and 12 of the reissue are "side-rocking," while those shown in Figs. 10 and 11 are not "side-rocking" within the meaning of the reissue. Do you agree with Mr. Brevoort in these views?

A. I do not. He is not only wrong in fact, but he contradicts the reissue. The terms "eccentric or side-rocking action" are, as I have before said, used throughout the reissue as synonyms. Eccen-

tric action means side-rocking and side-rocking means eccentric action, and the reissue, as if for the express purpose of leaving no doubt upon the matter, uses the word "side-rocking" only with reference to the very figures, 10 and 11, which Mr. Brevoort says do not side-rock. I quote from page 2 of the reissue, commencing at line 56: "Figs. 9, 10, and 11 are modified forms of the cylinder-bearing points or lines and the corresponding forms of *side-rocking* and rotary pistons adapted for co-operation therewith." The italics are mine. The pistons of these figures do side-rock—that is, their acting points describe figures resembling an epicycloid.

Int. 8. To what extent does your description of the meters of the Nash reissue contained in your answer to Int. 6 apply to all the forms of meter illustrated in the drawings of that reissue?

A. It applies to all of them so far as the description of the construction, motion, and mode of operation of the side-rocking piston and its case or cylinder are concerned. Fig. 7 shows different valves from those I have described, and Figs. 9, 10, 11, and 12, which latter has the form of piston shown in Fig. 3, show no valves at all.

Int. 9. Mr. Brevoort has testified that the defendant's or Hersey meter embodies the combinations of devices which form the subjects-matter of the third, fourth, fifth, and sixth claims of the Nash
290 reissue. What do you understand to be the inventions referred to in those several claims respectively?

A. I will premise by saying that according to my understanding of the matter all that can be claimed in a patent is the thing or things described, either separately or in combination, and the known substitutes or equivalents thereof, and that the use of loose language in the claims does not permit of a construction thereof which would be broader than the invention. The thing described in the specification and shown in all the figures of the drawings is a cylinder or case provided with points and depressions working in connection with an internal piston, also having points or depressions, and it is expressly stated in the patent that the piston must have less points of projection than the cylinder in order that the compound motion of the piston may be effected (page 2 of the reissue, line 117, etc.). Now, the compound motion referred to in this paragraph is, by reference to the first page of the reissue, lines 26, etc., defined as a revolution of the piston around its own centre and an eccentric or side-rocking action. The same motion of the piston is referred to, line 56, etc., on page 1, and in other places, one of which I will quote, page 2, line 83, etc.: "The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses $a\ a^1$ and projections $b\ b^1$ of such form or configuration as to allow of the rotation of the piston, not only upon its own axis, but around and across the center of the cylinder, and the space within the cylinder must be of such form and sufficiently larger than the piston H to allow it to have this compound motion."

I have endeavored to explain this compound motion and it seems to me clearly that the claims are limited to a piston having this

compound motion, when used in combination with a cylin-
291 der (and as the patent says that this motion is due to the fact that the piston has one less projection than the cylinder), the piston having at least one less projection than the cylinder in which it works.

As far as I can discover from an examination of the meter, this statement as to the unequal number of points being necessary is correct.

The third claim is to the combination of a piston with a cylinder, being the piston and cylinder having unequal numbers of points, as I have before described, so combined together that the piston shall have an eccentric or side-rocking motion within and upon continually changing lines, so as to effect the division of the chamber into receiving and discharging spaces, and by reference to the patent, especially at Fig. 12, it will be seen that the space within the cylinder is divided diametrically, and that the whole of one side of this contrivance is substantially, I do not mean to say exactly, a receiving chamber and the other side a discharging—that is, the receiving and discharging chambers are on opposite sides of the same diametrical line. Now, this is not the whole of the claim, but the piston must be in addition provided with internal water passages. These passages are the twelve passages, six for the entrance of water and six for the discharge of water, which I have before described. The claim is not limited to the precise number of each set of these passages, because in Fig. 11 there would be only four of these passages, two in each set, but in all cases all the exhaust passages must be separate from the induction passages and each induction passage must be separate from all the other induction passages, while each induction or discharge passage must be separate from all the other discharge passages. The passages thus referred to are the
292 only passages described in the patent, and if they are not so made separate and distinct each from the other the meter will not work. This third claim, in my opinion, includes all the passages, both induction and eduction.

The fourth claim is to the combination of the same piston and the same cylinder, having an unequal number of bearing points, and thus producing an eccentric or side-rocking motion of the piston and dividing the chamber into receiving and discharging spaces on opposite sides of the same diametrical line, when said piston has a free movement in said cylinder controlled only by the shape of the cylinder, the shape of the piston, and the flow of the water through the meter; and I understand this combination to be the combination of the piston and cylinder described, the latter having more points or projections than the former, so as to produce the compound motion of that piston when the latter is uncontrolled by mechanism, which, if used, would prevent the piston from following the prescribed path which is due to its own shape and that of the cylinder. The only passage in the specification which I find bearing on this limitation of the claim is on page 1, lines 51, etc., which refer to the connection of the piston with the registering mechanism, and is as follows: "And to accommodate this eccentric or side-rocking motion of the

piston it must have a free or shifting connection with the crank or mover of the registering mechanism."

The fifth claim is precisely the same as the fourth, except that it is limited to a piston made of vulcanite or hard rubber, and there is, therefore, no need of any further explanation of the meaning of it.

293 The sixth claim is to the same piston and same cylinder or chamber in combination with each other, the piston having one less projection than the cylinder, so that the former will have a side-rocking motion and divide the chamber into receiving and discharging spaces on opposite sides of the same diametrical line when the piston is provided "with ports controlled by said piston itself in its motion within said chamber." Now, I have studied the specification carefully, and it will appear from what I have before said that the specification refers to two entirely different sets of openings as ports, one set being the openings in the cylinder heads J and K, which are the openings bounded by the epicycloidal curves in the heads of the skeleton model. These so-called ports are not properly ports, as they are never controlled or opened or shut by any valve. One of them is an exhaust passage, and always an exhaust passage—always open—and the other is an entrance or induction passage, always open and never controlled at all by the movement of the piston.

The other ports mentioned in the specification are (see page 2, line 6, of the reissue and line 126, etc., page 2 of the reissue) the "ports $d\ d^1$ in the ends of the piston," communicating with the lateral passages $e\ e^1$, which communicate with the spaces c of the cylinder;" and the statement is that "the valve is formed within or is a part of the piston, and it consists of ports $d\ d^1$. These ports $d\ d^1$ in the ends of the piston are controlled by the motion of the piston, so as to admit and discharge the water properly from the meter, and these are the ports referred to in the claim, so that the claim, in short, is to the combination of the piston and cylinder, constructed and operated substantially as described in the patent, with exhaust and entrance ports or openings in the ends of the piston, which are, therefore, controlled by said piston in its operation, and thereby

294 control both the entrance and the discharge of water. I say both entrance and discharge because the claim expressly states that the receiving and discharging spaces are combined with ports, so that the claim includes both the receiving and the discharging ports in the ends of the piston. The claim does not say in combination with discharging ports alone or with entrance ports alone, but "ports," including both.

Int. 10. Have you read letters patent No. 211,582, dated January 21st, 1879, the original of the reissued letters patent here in suit, and do you understand the same?

A. I have read the patent several times and believe I understand it.

Int. 11. State whether or not you find in said original letters patent any suggestion or indication that the structures and combinations of devices which form the subject-matter of the third, fourth,

fifth, and sixth claims of the Nash reissue, here in suit, or any of them, formed inventions attempted to be patented in said original letters patent.

A. I do not.

Int. 12. Referring to the disclaimer immediately preceding the claims of the Nash reissue in suit, state what is the force and effect of that disclaimer in its relation to the description in the specification of the Nash reissue preceding it, that preceding description being a reproduction of the specification of the original Nash patent.

A. In my opinion the disclaimer has no force or effect at all in altering or changing the description of the meter in the specification or the meter which is referred to in the claims. The disclaimer was entirely unnecessary, as the description and claims of the original patent neither described nor claimed the thing which is disclaimed or a thing having the mode of operation of that which is disclaimed.

295 I produce a skeleton model of the thing which is disclaimed. Model in three pieces introduced in evidence and marked "Defendant's Exhibit Model Nash Disclaimer, W. H. T., spec. ex."

And it is perfectly evident without alluding to other distinctions, first that the piston and the cylinder have the same number of points, and therefore cannot have the side-rocking action described in the patent as arising from an unequal number of points; second, that the piston does not revolve on its own axis; third, that the points of the piston do not describe epicycloids; fourth, that each projection of the piston always acts in the same depression of the cylinder, and does not travel throughout all the depressions in the cylinder in succession, as in the Nash meter; fifth, that one point of the piston cannot by any possibility stand on one projection of the cylinder, as illustrated in Fig. 12 of the Nash patent, a position which is essential to the operation of the Nash meter. It is also evident that the water acts in a different way in the thing disclaimed from what it does in the Nash meter, and that the Nash meter will become leaky by wear, while the thing disclaimed will tend to grind itself tight and be as tight after some wear as it was originally.

Counsel for defendant introduces in evidence a model of the device shown and described in the Exhibit Galloway Patent here in evidence, and the same is marked "Defendant's Exhibit Galloway Machine, W. H. T., spec. ex."

Int. 14. Look at Defendant's Exhibit Galloway Machine, and state how the same resembles or differs from the apparatus
297 shown and described in the Galloway 1846 Patent here in evidence, upon which patent the disclaimer in the reissue is based.

A. I have examined the machine referred to in the question, but have not measured it, and, so far as I can see, it is a reproduction in metal from the drawings in the Galloway patent.

Int. 15. Compare Complainant's Exhibit D, which is a specimen of the Hersey meter alleged by the complainant to be an infringe-

ment of the third, fourth, fifth, and sixth claims of the Nash reissue here in suit, with the meters shown and described in said Nash reissue, and state how the same resemble or differ from each other in construction and mode of operation; state also whether you find in said Hersey meter the mechanism and combination of devices set forth in the four claims of the Nash reissue above referred to. In answering make such reference to the state of the art as you think necessary and give your reasons for any opinions you may express.

A. In making answer to the question I will refer to the specimen of the Hersey meter put in evidence by the complainant and marked "Complainant's Exhibit D," and to a diagram, which I now produce—

Said diagram is put in evidence and marked "Defendant's Exhibit Diagram of Motion of Points of Defendant's Piston, W. H. F., spec. ex."

(Here follows diagram marked p. 296.)

and will premise by saying that the piston and cylinder of the Hersey meter are constructed and operated precisely like the piston and cylinder of the Galloway engine disclaimed in the Nash reissue.

298 In the Hersey meter the number of points or projections of the piston and the number of points or projections in the cylinder or case are the same. Consequently the piston of Hersey cannot possibly have the side-rocking or eccentric motion of the Nash reissue, which motion the said reissue states, as I have quoted before, is "due to the fact that the piston has one or more less points of projection than the cylinder."

Secondly. In this Hersey meter in operation no one of the points of the piston ever rides upon or touches any of the points of the cylinder or case, as may be determined by turning the piston of Exhibit D round. This relative position of the points of the case or cylinder is found in all forms of the meter of the Nash reissue, and that meter cannot have the side-rocking motion described unless (see Fig. 12 of the reissue) such relative positions of the projections take place in the rotation of the piston.

Thirdly. In the Hersey defendant's meter each point or projection of the piston always operates in connection with one particular corresponding depression in the case, and never leaves that depression, while, on the contrary, in the Nash meter each and every point or projection of the piston traverses in succession all the depressions in the cylinder, and the meter could not operate unless each point of the piston visited in succession each depression in the cylinder.

Fourthly. The piston of Hersey never rotates on its own axis, while the pistons of all forms of the Nash meter are described in the patent as rotating, and do rotate, upon their own axes. The truth of this fact with respect to Hersey may be demonstrated by screwing a handle upon the centre pin of Hersey, and it will be seen that this handle never revolves during the motion of the piston, while in the

299 Nash meter, as I have before stated, the application of the handle shows that the piston does revolve on its own axis.

Fifthly. All the points of the Nash piston describe the same curve, following each other in succession over the same line, as shown in "Defendant's Exhibit Diagram of Motion of Points of Plaintiff's Piston," whereas, on the contrary, in the Hersey meter by reference to the similar diagram of motion of points of defendant's piston (in which the red circles show the motion of the piston points) it will be seen that each point of the piston describes its own curve, and that no other point of the piston ever traverses that curve.

Sixthly. The curve described by all the points of the Nash piston is epicycloidal. The various curves described by each one of the points of the Hersey piston are circles.

Seventhly. None of the curves described by the points of the Hersey piston surround or enclose the centre of the piston or case, whereas the single epicycloidal curve described by all of the points of the Nash piston does surround and enclose the centre of the piston and chamber.

Eighthly. The Hersey piston has neither an eccentric or side-rocking motion nor a rotation on its own axis, and therefore cannot have the compound motion which all forms of the piston of the Nash reissue are described as having.

The Hersey meter has not the eccentric or side-rocking motion described in the Nash patent and has no eccentric motion at all in any ordinary sense of that word. It has precisely the same motion as the connecting rod which connects the two driving wheels of a locomotive engine. Every point in that connecting rod will describe a circle of the same diameter and none of the circles
300 described by the various points will be concentric, and this is exactly the case with the Hersey piston. Every point in it will describe a circle of the same diameter that any other point will describe and no two of these circles will be concentric. A connecting rod such as I have described has no rotation on its own axis and no eccentric motion, neither has the Hersey piston.

All these differences in the construction and motion of the parts necessarily lead to the conclusion that the operation of the parts must be different in Hersey and in Nash, and that the water must be admitted and discharged, with reference to the points of the piston, in different ways in the two contrivances, thus necessitating a different construction of valves and different times of opening and closing the ports with reference to the points or acting parts of the piston. In the Nash meter, as before said, substantially all the spaces on the right-hand side of the line Z Z are receiving water and substantially all the spaces on the left-hand side of that line are discharging water. I refer to the "Exhibit Diagram of Motion of Points of Plaintiff's Piston," and also to Fig. 12 of the Nash reissue; and the line of pressure of the water which causes the piston to revolve is in the line of the arrow marked on these diagrams, and the patent says that this line of pressure should be as nearly as possible at right angles to the direction of the motion of the piston, and in another place the patent states, line 95, etc., page 1, "The valve opens some and closes others of the ports in succession in such a manner as to keep the line of pressure of the water as nearly as

possible at right angles to the direction of the eccentric or side-rocking and rotary movements of the piston, and thereby avoid any undue lateral pressure of the water upon the piston."

I understand that the point a on the diagram of motion of
301 points of plaintiff's piston is to occupy successively the points a^1 a^2 a^3, so that this point rocks sidewise through the distance from b to a^3, and then rocks back again in the opposite direction through the same distance until it arrives at a^4, and all the points of the piston, as I have before said, will follow the same path and side-rock on changing lines to the same extent, and this side-rocking cannot take place unless the piston revolves on its own axis and unless there are more points on the cylinder than on the piston. The dotted lines on the diagram show some of the changing lines in which the points of the piston side-rock, and it will be seen that the line of pressure of the water is nearly at right angles to them.

The patent says in the phrase before quoted that any undue lateral pressure of the water upon the piston should be avoided. This direction is correct, because the tightness of the Nash meter, and therefore its accuracy in measuring, is due to the relative shape and size of the piston and cylinder and not to the effect of the water pressing the contacting points of the piston against the cylinder.

Adjourned to Saturday, July 21, 1888.

PROVIDENCE, *July* 21, 1888.

Present: Counsel as before.

I think I have omitted to state that in the Nash meter the operation of the valves—that is, the opening and closing of the ports in the ends of the piston by means of the piston carrying these ports under the cylinder heads or ends—must be such that substantially all the induction or entrance ports on one side of the line
302 Z Z are open and all the discharge ports closed, while on the other side of that line substantially all the discharge ports are open and all the entrance ports closed.

Turning now to the "Exhibit Diagram of Motion of Points of Defendant's Piston" there is drawn across it the line x y, which is as near in position to the line Z Z drawn on the diagram of motion of points of the Nash meter as the great difference between the two meters will permit of, and the arrow W on the piston shows the direction of its motion. Now, on the right of this line all the entrance ports are open and the discharge ports closed, and the unbalanced pressure of the water on that side of the piston, as indicated by the arrows g g, tends to shove the whole piston and the piston points on the left of the line x y into contact with the sides of the cylinder or containing case. This feature is not found at all in the Nash meter, and if it did not exist in Hersey this meter would be useless. In the Nash meter, pressure on the right of the line Z Z tends to revolve the meter and not to force the points of the piston against the inside of the cylinder.

Turning again to the left of the line x y in the diagram of the Hersey meter, we find that there are three contacting points in con-

tact with the sides of the cylinder, and these three points, in connection with two on the right of the line, divide the left-hand side of the cylinder into six spaces, and there is no communication between any of these spaces. On the contrary, in the Nash meter there is only one continuous space on the left hand of the line Z Z. In the Hersey meter there is a continuous entrance of water on the left hand of the line *x y*, and in the plaintiff's Nash meter there is no entrance of water on the left hand of the line Z Z. In the Hersey meter on the left-hand side of the line the water is
303 entering, as indicated by the arrows *o*, into three different and separate compartments, and is discharging, as indicated by the arrows *p*, from three other distinct and separate compartments; consequently each one of the projections *q q q* has pressure on one side of it and exhaust on the other; consequently each of these piston-points act like the piston of an ordinary rotary engine to cause the piston to revolve. There is no such mode of operation as this in the plaintiff's meter.

Now, I think it will be evident from this that the time and order of controlling the valves in the defendant's meter must be entirely different from the time and order of controlling the valves in the plaintiff's meter, and consequently that the valve ports must be differently arranged with reference to the valve or valves which open and close those ports, and that there is a pressure of water in the defendant's device which is not found in the plaintiff's, and that the defendant's meter is operative at all solely by reason of this pressure.

In consequence of this last-named difference of operation the defendant's meter keeps tight when the piston and cylinder wear.

In order to illustrate this fact clearly I have had two pistons made for the "Exhibit Model Nash Disclaimer," one of which is about an eighth of an inch smaller in diameter than the other. This model is also a skeleton model of the defendant's Hersey meter, and by using the pistons alternately within the cylinder it will be seen that the small piston is just as tight and makes as good contacts as the large one.

I have before stated that there were passages, each separate and distinct from the other—some for the entrance, some for the discharge of water—in the pistion of the plaintiff's meter. There are no such passages in the piston of the defendant's meter.
304 The defendant's meter has one single opening through the centre of the piston, and this opening is not a passage controlled by ports and valves, sometimes open and sometimes shut, like the plaintiff's passages, but is always open, and all the water discharged by the meter is continually passing through it. The mode of operation of this passage is entirely different from the mode of operation of any one or all of the passages in the piston of the plaintiff's meter.

Moreover, an exhaust passage always open through the centre of a revolving piston was not new in the Hersey meter. It may be seen in the patent granted to Chapman November 12th, 1867. It is true that this patent is for a rotary steam-engine, and that ex-

haust steam instead of exhaust water passes through it; but the claims of the plaintiff's patent in suit are not limited to a meter, but include motors, which are steam-engines. In the Hersey meter Chapman's device is used, and the passages of the Nash patent are not used. Chapman also shows a passage for the entrance of steam through a rotary piston, but this passage does not act like plaintiff's passages, as it is always open and not controlled by a valve like the plaintiff's passages are.

In the plaintiff's meter the ports for both entrance and discharge of water are, as I have before explained, in the ends or sides of the piston, and the reissue so describes them. In the defendant's meter there are no ports in the ends or sides of the piston. The defendant's ports are not in the rotating piston, but in the ends or heads of the stationary case, as may be seen by examining the Hersey meter, Complainant's Exhibit D. In plaintiff's meter the stationary ends of the case or cylinder act as the valve; in defendant's meter the revolving piston itself acts as the valve. In these respects the defendant's meter is unlike the meter of the plaintiff's patent,
305 and like the arrangement of ports and valves in the patent granted to Ortlieb November 19, 1867. In Ortlieb the ports are in the ends or heads of the cylinder and are stationary and are covered and uncovered by the rotation of the piston, and this is the case in defendant's meter.

In the plaintiff's meter the piston is not controlled by any crank or other mechanism which would prevent it from taking the positions which are due to the pressure of the water on the piston and could not be attached to a crank in the ordinary way, no matter how accurately it was constructed, because it has the compound rotary and side-rocking motion which I have so often referred to. It is true that in Fig. 10 of the Nash reissue the piston of the plaintiff's meter is controlled by a crank in its motion, but I doubt much whether this form of the Nash meter as drawn would get around at all. The defendant's meter is not controlled in its motion by a crank attached to it in the usual way, but it might be so controlled without injury or without affecting its operation if accurately constructed, because, as I have before said, the curves described by every point in the defendant's piston are true circles.

When two revolving parts in a machine are connected together by a crank, as the counters are connected with the pistons in both plaintiff's and defendant's meters, it has been customary for at least thirty years, to my knowledge, to let the crank pin enter into a slot in the crank of the driven mechanism or to connect the driven mechanism with the crank pin by means of a drag-link, and either of these plans would be substitutes for the mode of driving the counters or registers in both the plaintiff's and defendant's meters; but it is not necessary to go into the general state of the art
306 to invalidate a broad claim for any and every kind of a rotary piston which is uncontrolled by a crank or other mechanism, and is free to take the position into which it is forced by the entering water or steam. The patent to Galloway of 1846, as I have before stated, describes a piston and cylinder like the defendant's and

operating in the same way, and its piston drives mechanism by means of a crank, and the piston is not at all controlled by the crank, but can take the positions due to the operation of the steam upon the piston. In this Galloway engine, as will appear by reference to Figs. 5 and 6 of the patent, the hole in the piston is of considerably greater diameter than the crank pin; consequently the crank pin does not fit the hole, and the piston can describe a different circle from that described by the crank pin; consequently the piston is uncontrolled, as the defendant's piston of the same kind is, and has a free movement within its cylinder, controlled only by the shape of the cylinder, the shape of the piston, and the flow of steam through the engine. This crank pin of Galloway is slotted longitudinally, and also faced off flat. The part of the crank pin thus cut away is replaced by a separate part, and the two parts are kept apart by a spring, so that on one of the diameters of the crank pin the hole which it enters is fitted by the pin. This construction, as I understand it, is for the purpose of avoiding chattering to a certain extent, but would not prevent the piston from freely taking the position which the steam forced it to take.

The piston of plaintiff's contrivance is made of hard rubber or vulcanite; so is the piston of defendant's meter. Vulcanite was a well-known substance many years prior to the date of the Nash patent, and it would not be a patentable invention to make a well-known piston, such as that shown in Kinematics, which
307 is the plaintiff's piston, of this special well-known material, even though it was better than a metal piston, owing to the well-known properties of the material; but, in addition to this, hard-rubber pistons were known to me more than twenty years ago, and have been applied to water meters, as shown in the patent to Henry F. Read, dated in 1869 and reissued in 1871, and it appears to me that no valid patent could be granted for making one well-known kind of meter piston of hard rubber when another well-known kind of meter piston had been previously made of hard rubber.

Turning now to the claims of the Nash reissue, all the claims alleged to be infringed have in them substantially, if not exactly, the same language relating to the piston and its case, and this piston and case are elements of all these claims, viz: A piston and cylinder constructed and operating as I have before set forth at length. From what I have said before with reference to the defendant's meter it will appear that I believe that it operates in an entirely different way from the meter of the plaintiff's patent and that its piston has not the side-rocking or eccentric motion upon continually changing lines, which is the characteristic feature of the plaintiff's piston; also that the piston and cylinder of defendant's meter are not constructed like the plaintiff's—that is, do not have one less point or projection on the piston than in the cylinder—but, on the contrary, have an equal number of points both on the piston and cylinder, and therefore cannot have the side-rocking motion of the plaintiff's patent which that patent states is "due to the fact that the piston has one or more less points of projection than the cylinder."

If the defendants do not have the piston and cylinder of
308 the plaintiff's constructed and operating substantially as described in the plaintiff's reissue they do not use the invention referred to in any of the claims said to be infringed, because those parts are elements of all these claims. In my opinion they do not have them, and therefore do not use the inventions set forth in the third, fourth, fifth, and sixth claims of the Nash reissue.

But there are other reasons for this opinion, viz: The third claim includes the internal water passages. I have already described the water passages, and, I think, proved that the defendants do not use those passages, but, on the contrary, use an old and single outlet for water or steam such as was previously known.

The fourth claim includes, it hardly can be called an element, but the idea that the piston shall have a free and uncontrolled movement. The piston of Galloway, which is like the defendant's and unlike the plaintiff's, had a practically free and uncontrolled movement, and therefore, if this claim be construed broadly enough to cover the defendant's device, it must be construed broadly enough to cover Galloway, and therefore be bad for want of novelty.

The fifth claim is the same as the fourth except that it is limited to the plaintiff's side-rocking piston when made of hard rubber. The defendants do not use this side-rocking piston, and I have already stated that the claim is invalid in view of Kinematics (which exhibits the same side-rocking piston) and of the fact that other kinds of pistons had been previously made of hard rubber.

The sixth claim is to the same side-rocking piston and chamber of the plaintiff's, which is not used by the defendants when the receiving and discharging spaces into which the piston divides the cylinder communicate with ports controlled by said piston itself in
its motion within the chamber. The defendants do not use
309 the piston or the combination of chamber and piston described in the reissue. Neither do the defendants use "ports in the ends of the piston communicating by means of passages in or through the piston with the spaces of the cylinder" (see Nash reissue, line 6–11, page 2, which is the passage in the specification that this sixth claim most particularly refers to). Neither do the defendants have ports or passages which open or close in similar order to those of the Nash reissue. The defendants do use ports or passages opened and controlled by the piston, but these ports are not revolving ports in the ends of the pistons, like the plaintiff's, but are stationary ports in the heads of the cylinder like those in the Ortlieb patent. In the plaintiff's contrivance the heads or ends of the cylinder or case are the valves; in the defendant's meter the piston itself is the valve as in the Ortlieb contrivance.

In my opinion the defendants do not use any single one of the elements referred to in the sixth claim, and I say the same of the third, fourth, and fifth claims, saying it of the fifth because it is limited to "said piston" formed of hard rubber, and "said piston" is a piston having the side-rocking or eccentric motion described in the patent, and so constructed as to operate in that way; while the

defendant's piston has no such motion, and is not constructed to operate in such a way.

310 PROVIDENCE, *July* 26, 1888.

Present: Counsel as before.

Cross-examination by Mr. BULL:

X Int. 16. You have testified that you were appointed examiner in the Patent Office in the year 1847 or 1848, and was an examiner there for about four years and a half. How many examiners were there in the Patent Office at that time?

A. Four principals and four assistants till 1851, I think, and then six principals and six assistants. I was appointed a principal examiner under the law increasing the force, passed, I think, in 1847. Before I came there there were only two principal and two assistant examiners.

X Int. 17. What other classes besides those you have mentioned had you charge of as principal examiner?

A. In addition I had, before the increase of the force to six principal examiners, the class of metallurgy, navigation, civil engineering, and fire-arms; also general miscellaneous.

X Int. 18. Do you know or have you any idea how many patents were issued during the years 1848, 1849, 1850, 1851, and 1852 for rotary engines of every style, rotary pumps, and rotary meters?

A. I have no idea.

X Int. 19. I have examined the published Patent Office Index for these years and have found only five patents granted for such rotary structures. Are you able to say that more than five or six such patents were granted during that period?

A. No, I am not; I can't remember. I do remember that I examined a great many applications for patents for rotary engines, etc. When I resigned I left in the Patent Office a manuscript
311 index that I had made of more than two hundred rotary engines not patented in this country, with sketches and short descriptions.

X Int. 20. By what terms may the motion of a body, however complex that motion may be, be indicated? Is it not a fact that the motion of any body may be indicated by two terms, one representing its motion of translation, as it is called, and one representing its motion of rotation?

A. I should think not, because the bodies may have other motions than translation and rotation.

X Int. 21. What other motions may a body have besides translation and rotation?

A. Take the very Nash meter. It has a motion of rotation; it has a side-rocking or eccentric motion, and its centre might travel, which would be translation, in a curve or straight line, and it might at the same time tip so as to lie at various angles to the horizon at various times.

X Int. 22. To what point or points of a body does the motion of translation relate, and state what you regard as the motion of translation of a body.

A. The motion of translation relates to all points of a body. Different points may have different motions of translation, as I understand it. I have not for many years looked into these general theoretical questions, which are usually of no use in patent cases. If I remember right, the general idea of the motion of translation is the motion of a body through space, aad it would be difficult to separate it from the motion ordinarily called of rotation.

X Int. 23. Is it not a fact that in describing the motion of translation of a body through space the centre of that body is alone considered?

A. I don't know what they consider. As I said before, I have given up the theory of mechanics for many years, using the term "mechanics" in its proper sense, as distinguished from machinery.

312 X Int. 24. British letters patent to Galloway of 1846 and American letters patent to Read, No. 4391, and to Ortlieb, No. 71208, and to Chapman, No. 70802, have been offered in evidence. Do you think that either of these patents anticipates either the third, fourth, fifth, or sixth claims of the Nash reissue in suit?

A. I do not, as I understand those claims, and my understanding of those claims will appear from my direct examination.

X Int. 25. Referring to page 434 of Reuleaux's Kinematics, in evidence, do you find there described any ports for the form of mechanism illustrated, or any indication of how the ports shall be placed?

A. I find none. The only statement is that they are steam-engines, and therefore must have steam and exhaust ports of some kind or other. That statement is on the preceding page.

X Int. 26. In your answer to Int. 6 you say that each of the points of the Nash piston traces very nearly the curve called an epicycloid, the variation from an *an* epicycloid being due to the fact that the piston is like a cog-wheel working upon a circular rack. Is the variation from an epicycloid referred to generally known in mechanics as a cog-wheel epicycloid?

A. I don't know by what term it is generally known.

X Int. 27. In the same answer you have defined an epicycloid as "the curve drawn by any point in the tire of a wheel when the wheel is revolved with its tire resting and traveling upon a cylindrical surface." Must the wheel referred to be itself circular to describe the curve referred to?

A. If I remember aright the definition of an epicycloid, it must be.

X Int. 28. You have stated it as your opinion that in the Nash type of meter the device will become leaky by wear, while in the Hersey type the pressure of the water and the form of the
313 parts will cause the piston to take up its wear and remain tight. Do you consider this a characteristic or essential distinction between these types—that is, between meters of this class having pistons which do or do not rotate about their own centres?

A. I consider the Hersey and Nash meters as meters of different classes, being as different from each other as they are from some other kinds of rotary meters. I consider that the prevention of leakage is an essential distinction in mode of operation when compared with a meter which grows leaky by wear.

X Int. 29. Do you consider this supposed or alleged tendency in the Nash structure an inherent characteristic of that type of meter?

A. I do, unless the points of the piston are provided with elastic packing which will take up the wear. The Hersey meter remains tight without such elastic packing.

X Int. 30. And do you consider this a feature of essential distinction between the two types of meters?

A. I do in their operation, and it proves that the cylinders and pistons must be of different form, have different motion, and have also different valve motion.

X Int. 31. You have in your direct deposition criticised the use of the term port as applied in the specification of the patent in suit to the central holes in the ends of the case. What is your definition of a port and what is your definition of a valve?

A. A port is a passage for live or exhaust steam or entering or discharging water or other fluid which is at times closed by a valve, so that the piston or its equivalent which is acted upon may be subjected to or relieved from pressure at certain times.

A valve is anything which closes and opens a passage of any kind. An ordinary cock or faucet is a valve; so is the damper in a stovepipe. Sometimes the passage moves with reference to the valve. Usually the valve moves with reference to the passage.

314 X Int. 32. Suppose we have two plates having relative motion and said plates each contained a hole caused to coact by the relative motions of the plates to admit suitable fluid to or from a piston. Which would be the port and which the valve in such a structure?

A. The question is not sufficiently definite to enable me to give a definite answer.

X Int. 33. Take, for example, a cylindrical piece of metal hollowed out, such as a piece of pipe closed at one end, having a cylindrical hole through its wall forming a passage for acting fluid to pass through the wall and pipe to a piston. Let this hollow cylinder be enclosed in a case having a cylindrical hole which by the movement of the hollow cylinder or the case will at intervals be brought opposite the hole in the cylinder above referred to, and let this hole in the cylindrical case also form a part of a passage for the acting fluid. Which would be the port and which the valve in this case?

A. I do not pretend to understand the description, but it seems to me to describe an inoperative device, and I cannot, therefore, answer the question.

X Int. 34. I place in your hands a sketch illustrating such a device as is described in my previous question, the internal hollow cylinder in this case being the moving part. Which do you consider the valve and which the port?

A. In this sketch *c* would be the steam pipe; *b* would be the steam or valve chest; *d* would be the valve, and *a* would be the port.

X Int. 35. I have lettered the hole in the cylindrical case *e* and the hole in the interior cylindrical part *f*. As I understand you, neither of these parts indicated by the letters *e* and *f* are in your opinion "ports"?

315 A. They are not in the usual acceptation of the term. *e* is a part of or continuation of the steam pipe, and *f* is a passage through the valve somewhat like the passages through an ordinary gridiron valve, and the whole of that portion of the valve which is below the letter *x* is useless and so is the bore *y*. The valve would be the same and work in the same way if it were made a solid plunger.

Sketch offered in evidence and marked "Complainant's Exhibit Valve Sketch, W. H. T., spec. ex."

X Int. 36. You have testified that in your opinion the Hersey meter contains certain ports in its end plates. Are not these ports in that meter controlled by the piston?

A. Yes; and I in substance said so in my direct examination.

X Int. 37. And the ports in that meter are each separate and distinct from each other, are they not?

A. They certainly are. I mean the ports made in the head or end plates of the case.

X Int. 38. And the passages through that part of the Hersey meter which you call the valve are all in communication with each other, are they not?

A. There are no passages through the piston of the Hersey meter, the piston, as I have stated, acting as a valve. There is one single passage through the centre of the piston of the Hersey meter from end to end thereof, and that passage, as I have before stated, is an escape passage for all the exhaust ports and passages.

X Int. 39. Then it is true, is it not, that in both the Hersey and the Nash structures the ports are all separate and distinct from each other, and must be so in order that the device shall be operative, and that in both said structures that part of the device which

316 acts as the valve contains a single hole always open for the passage of fluid?

A. In both meters the ports which are properly ports are all separate and distinct from each other, as they are in almost all classes of rotary meters, and must be so in order that the meters shall operate. More than one part of the device acts as a valve in the Nash meter. One head of the case acts as the exhaust valve and the other head of the case acts as the entrance valve. The large central hole in one end of the case in Nash is an entrance passage and the large central hole in the other end of the case is an exhaust passage, as I have said before. The hole through the centre of the piston in the Hersey meter, which piston acts as a valve, is for exhaust water only.

X Int. 39. In the Hersey meter the piston which act- as the valve (as you employ the *the* term) contains a hole always open. In the Nash structure the two end plates act as valves and each of these end plates contains a hole aways open. Is this true as you employ the term valve?

A. Yes; it is the truth, but not the whole truth. The hole in one of the heads of the Nash case is for exhaust, and the hole in the other head for the entrance of water, while the hole in the Hersey piston is solely for the exhaust or discharge of water.

X Int. 40. What is your definition of the term "eccentric" as applied in mechanics?

A. A circular piece of metal revolved on a pivot which is not the centre of the circle.

X Int. 41. Does the piston of the Hersey meter, in your opinion, occupy an eccentric position with relation to the case when the meter is in operation?

A. The Hersey piston never revolves as an eccentric does.
317 If the containing case be considered as a circle, which it is not, the piston occupies a great many positions in its rotation where the centre of the piston is not coincident with the centre of the case because the centre of the Hersey piston travels in a circle without revolution as the moon travels around the earth, except that the moon always turns the same side to the earth. A person might call these various positions excentric, as the centre of the piston is never coincident with the centre of the case, although every position of the centre of the piston is at the same distance from the centre of the case—that is, the circle which the centre of the piston describes is concentric with the centre of the case.

X Int. 42. It is a fact, is it not, that the centre of the eccentric in the ordinary "eccentric" employed in mechanics describes a concentric circle around the centre of the shaft upon which it is mounted?

A. Yes.

X Int. 43. Is not a crank the equivalent of an eccentric in mechanics?

A. They both will give the same motion to a connecting rod, or eccentric rod, as it is called, when used with an eccentric, but they are not always equivalent. The advantage of an eccentric is that it does not necessitate the cutting in two of the shaft upon which it is mounted, while with a crank you must cut the shaft in two. Secondly, a steam-engine could not be made to rotate a shaft if it acted upon an eccentric upon the shaft, while it always does by means of a crank.

X Int. 44. Is there such a term as "eccentric motion" employed in mechanics? If yea, please state what that motion is.

A. Yes; I have often heard it applied to a reciprocating
318 motion either in straight lines or in the arc of a circle produced by means of an eccentric strap and rod. For instance, you say a valve is worked by an eccentric motion. If a body be moved in a circle it may be said to move eccentrically with refer-

ence to a point which is not the centre of that circle, but the body itself would describe a circular path.

X Int. 45. The use of the term "eccentric motion" referred to in your last answer is synonymous with the term "eccentric" or "eccentric device," is it not?

A. It is in the first part of the answer synonymous with the eccentric, its strap and rod.

X Int. 46. Referring to the smaller piston of "Defendant's Exhibit Model Nash Disclaimer," is that piston like the larger piston of the same exhibit except that it has an equal amount of material taken off all around its edge?

A. I have never measured it, but it appears to be so made.

X Int. 47. Is it your opinion that the piston of the Hersey meter in actual use would wear down evenly all around, as illustrated by this smaller piston?

A. Probably, and I may say certainly, both case and piston would wear, and my opinion is that they would wear so equally that the contacting surfaces would be as tight after wear as they were before.

X Int. 48. Do you mean by your answer to have it understood that you think that the piston and case by use would wear down equally on all sides?

A. I do not know that I exactly understand the question. My opinion is that the circle of the case traversed by each and every point of the piston and the points of the piston, each one of which traversed one of those circles, would after long use and wear make practically as tight a joint as before. I can't tell whether the wear would be exactly equal on every part of the piston and on
319 every part of the case, but my opinion is that it would be practically so, although possibly the wear might be greatest around the ends of the points of the piston and of the case.

X Int. 49. Then you are not able to swear that by actual working use the larger piston of this model of Nash disclaimer would be worn down to the exact shape of the smaller piston of this model, and you are not able to swear that after such use the curves of the case would remain the same as they are in this model. Am I right?

A. No; I am not, as I have never tried; the two pistons were made to illustrate the fact that a piston of smaller diameter would work tight in Hersey, while it is perfectly evident that a piston of smaller diameter would not work tight in the Nash meter.

X Int. 50. Referring now to the Ortlieb and Chapman patents in evidence, are you of the opinion that the ports of the structures described therein are controlled by the piston itself?

A. In the Chapman patent they are not controlled by the piston itself, and I have never said so, and I am of the opinion that they are so controlled in the Ortlieb patent.

X Int. 51. What figures are described by the central point of the piston shown in Figs. 3, 9, 10, 11, and 12?

A. Figs. 3 and 12 are the same, and I have never tried to find out what figure is described by the centre of the piston in them—I should suppose a polygon, all of whose sides are concave curves,

and the same would be true of Fig. 9 and, I think, Fig. 11. In Fig. 10, if it would work, which, as I have before said, I doubt, the figure described by the centre of the piston would approach a
320 circle. This is a mere opinion. What I have looked at is the motion of the points which do the work in connection with the case.

Redirect examination by Mr. FISH:

R. D. Int. 52. You have testified that in the movement of the piston of the Hersey meter the point at the centre of the piston describes a circle concentric with the centre of the case, at which centre is the shaft which drives the registering mechanism. You have also testified in answer to X Int. 42 that the centre of the eccentric in the ordinary "eccentric" employed in mechanics describes a concentric circle around the centre of the shaft upon which it is mounted. In so far as the motions of the Hersey piston and the ordinary eccentric are alike in the particular above referred to, does their resemblance justify a description of the motion of the Hersey piston as "eccentric," and what is the relation of their motions in other particulars?

A. No; it does not justify the description of the motion of the Hersey piston as an eccentric motion. If the Hersey piston had the motion of an ordinary eccentric, each point of the piston would have to visit all the depressions in the case in succession; whereas on the contrary it is absolutely necessary that each contacting point of the piston should work in combination with only a single depression in the case. The motion of an ordinary eccentric is the motion of the earth on its axis; the motion of the Hersey meter is the motion of the moon around the earth, except that the moon always turns the same side to the earth. If, in an ordinary eccentric, a line be drawn from the centre of the shaft upon which it is mounted
321 through the centre of the eccentric, every point in that line will describe a circle, but every point will describe a circle of different diameter. All these circles will be concentric, and all of them will surround the shaft on which the eccentric is mounted. If in the Hersey meter a line be drawn through the centre of the case and the centre of the piston every point in that line will describe a circle of exactly the same diameter, and none of them will be concentric with any of the other, and none of them which are described by points which are active in the operation of the meter will surround the centre of the case.

HENRY B. RENWICK.

Attest: WILMARTH H. THURSTON,
Special Examiner.

322 Circuit Court of the United States, Southern District of New York. In Equity.

NATIONAL METER COMPANY
v.
BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS.

It is hereby stipulated and agreed that Simon G. Croswell, of Boston, Mass., shall act as special examiner to take the testimony on behalf of the defendants in the above-entitled case in the district of Massachusetts under the 67th rule in equity of the Supreme Court of the United States, as amended.

BROADNAX & BULL,
Solicitors for Complainant.
LIVERMORE & FISH,
Solicitors for Defendants.

323 Circuit Court of the United States, Southern District of New York. In Equity.

THE NATIONAL METER COMPANY
vs.
THE BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS.

Evidence for defendants taken pursuant to the 67th rule of the Supreme Court of the United States in equity, as amended, before me, Simon G. Croswell, special examiner, 40 Water street, Boston, Mass., July 27th, 1888.

Present: J. E. Bull, Esq., of counsel for complainants, and F. P. Fish, Esq., of counsel for defendants.

324 *Deposition of John P. K. Otis.*

Direct examination by F. P. FISH, counsel for defendants:

Int. 1. What is your name, age, residence, and occupation?

A. John P. K. Otis; 35 years; reside — Worcester, Mass.; travelling agent for Union Water Meter Co. of Worcester, Mass.

Int. 2. How long have you been connected with that company, and how familiar have you been with its business?

A. I have been connected with it more or less since 1873, and the familiarity with the business is this: J. C. Otis, my father, is treasurer of the company. I have been in the office and on the road practically since 1876. During father's vacations I have had charge of the business while he has been gone, as at the present time, my father now being on his vacation.

Int. 3. State whether or not the Union Water Meter Company has manufactured rotary piston water meters. And, if so, can and will you produce cuts illustrating such rotary meter?

A. The Union Water Meter Company has made and are now

making rotary piston water meters. I can produce cuts of the same, and do so. I produce two different cuts showing the same meter.

(Cuts produced by the witness which are in circulars of the Union Water Meter Company are introduced in evidence and marked "Defendant's Exhibits Cuts Union Rotary Piston Water Meter, Nos. 1 and 2, S. G. C., sp. ex.)

325 Int. 4. The cut No. 1 illustrates 3 views of the meter. The cut No. 2 illustrates 2 views of the meter. What parts are shown in each view?

A. Cut No. 1 shows the whole meter at the left, the pistons and gears in the centre, and the body of the case with the parts at the right. Cut No. 2 shows the whole meter at the left and the body of the meter with the pistons just being withdrawn at the right.

Int. 5. State whether or not the rotary water meter shown by said cuts has been patented. And, if so, can you produce the patent under which the same is made?

A. It has been patented. The patent can be produced. I produce the patent.

(The copy of patent 178,829, dated June 13, 1876, to B. Fitts, is introduced in evidence and marked Defendant's Exhibit Fitts' Patent, S. G. C., sp. ex.

Plaintiff's counsel makes the same objection to the introduction of said patent as was made to the introduction of the Chapman, Read, and Ortlieb patents.)

Int. 6. Of what material has the Union Water Meter Company made the pistons of its rotary meters such as you have referred to?

A. Of bronze and vulcanized or hard rubber.

Int. 7. When did they first begin to make those pistons of vulcanized or hard rubber?

A. In the spring of 1876.

Int. 8. How are you able to fix that date?

A. By bills from the Boston Belting Company and by entry in day book of sale of meter with rubber pistons in 1876. An
326 8-inch meter was on exhibition in the Centennial exposition of 1876. I mean a rotary piston of this type.

Int. 9. Of what material were the pistons of that 8-inch meter made?

A. Of vulcanized rubber.

Int. 10. Did you personally have anything to do with exhibiting that meter at the Centennial?

A. I was there a short time in charge through the fair.

Int. 11. What became of that 8-inch meter with the rotary hard-rubber pistons?

A. The hard-rubber pistons were taken from Philadelphia before the close of the fair; were put in another body. Said last-named meter was then sold to Amoskeag Manufacturing Company, Manchester, New Hampshire, September 2, 1876.

Int. 12. Have you here any of the original books of account of

your company; if so, do you find in them any entry of the sale of that meter to the Amoskeag Company?

A. I have the day book for 1876 here; on page 170 I find the charge to the Amoskeag Manufacturing Company "to 1 8 rotary meter (rubber floats)." The number of the meter was 6001.

Question and answer objected to on the ground that the book referred to by witness is not offered in evidence.

Int. 13. What do the words "rubber floats" in the entry refer to?

A. They refer to the vulcanized rubber pistons.

Int. 14. Are you willing that the day book of the Union Meter Company which you have produced should be introduced in evidence in this case?

327 A. I should have to refer that question to our president, Mr. Phineas Ball.

Int. 15. Will you refer the question to him, and, if he is willing that the book should be offered in evidence, will you send the same to the magistrate taking your deposition to be marked by him "Defendant's Exhibit Union Meter Company, 1876, Day Book No. 3," in this case?

A. Yes, sir.

Int. 16. Is there any objection to the inspection of this book by complainant's counsel or Mr. Nash, its engineer, at any reasonable time?

A. No, sir; none that I know of.

Int. 17. Can and will you produce the original bills from the Boston Belting Company, to which you refer in your answer to interrogatory 8?

A. Yes, sir; I can and do hereby produce them.

Bills produced by witness, seven in number, are introduced in evidence and marked "Defendant's Exhibits Union Water Meter Company Bills No. 1–7, S. G. C., sp. ex."

Int. 18. State what articles are referred to in those bills as "floats," "small floats," "w. m. rubbers," "water-meter rubbers," "hard rubbers," and "rubbers in mould."

Question objected to as incompetent, irrelevant, and immaterial; also on the ground that the witness is not competent to answer the questions. The introduction of said bills in evidence is also objected to on the same grounds.

A. They refer to the vulcanized rubber floats or pistons for the rotary piston meters.

328 Int. 19. State whether or not to your knowledge the Boston Belting Co. made any vulcanized rubber floats or pistons for the Union Water Meter Co. in the years 1875 and 1876.

A. They did.

Int. 20. State whether or not the Union Water Meter Co. used hard-rubber pistons in its rotary meters from and after 1876; and, if so, to what extent.

A. They have and are now using hard-rubber pistons. I should

think about one in every 10 meters made at the present time are made with hard-rubber pistons; both bronze and hard-rubber pistons are kept in stock; for a few years, say from 1878 to 1881 or 1882, hard rubber was almost entirely used for pistons, especially in the small sizes—below two-inch size.

Int. 21. How was it between 1876 and 1878?

A. I cannot state positively.

Int. 22. Were hard-rubber pistons used at all during those years?

A. Yes, sir.

Int. 23. Why did the Union Water Meter Co. begin to make pistons of hard rubber?

(Same objection as to Int. 18.)

A. In order to get a piston as light as possible or lighter than metal.

Int. 24. State whether or not the construction of the Union rotary piston meter has been the same from 1876 to the present time

A. It has been practically the same in reference to the pistons or working parts.

Int. 25. Has there been any change in the connections between the pistons and registering apparatus?

329 A. There has been a change in the form of what we call the intermediate gearing between the working parts and register. That change is a different construction of the intermediate gearing.

Int. 26. Which was introduced into the market first—the rotary piston meter of the Union Water Meter Co., with hard-rubber pistons, or the rotary meter of the National Meter Co., known as the Crown, which has a hard-rubber piston?

(Question objected to as incompetent, irrelevant, and immaterial.)

A. The rotary piston meter made by the Union Water Meter Company.

Int. 27. Can you recall any circumstance which fixes that fact in your mind?

A. About the time of the introducing of the Crown meter our people looked up the subject to see in regard to a patent for hard-rubber pistons to be used in water meters.

Int. 28. What was their purpose in looking it up?

A. To obtain a patent on the use of hard rubber for that purpose if possible.

Int. 29. Why did they not seek to obtain such a patent?

A. Heard our ex-mechanical engineer, Mr. Benaiah Fitts, say that it had been used between 3 and 4 years previous to the time of his looking the matter up.

Cross-examination by J. E. BULL, Esq., of counsel for complainants:

X Int. 30. You have testified that you have been in the office and

on the road practically since 1876 for the Union Water Meter
330 Company. How much of your time during the years 1876, '77, and '78 were you in the office of said company or on the road engaged in its business?

A. In the years 1877 and 1878, in the office and shop 4 days a week; did not commence to travel for them till January, 1884, to any extent. In 1876, about the middle of the year, the 1st of August, came back from Portland, Maine, where I had been engineer of the Portland Water Company, and through the rest of that year I was with them about the same as in 1877 and 1878.

X Int. 31. What connection did you have with the Union Water Meter Company during the year 1875?

A. Doing a portion of their draughting.

X Int. 32. State, if you can, what part of the year 1875 you were engaged making drawings for the said company.

A. From two to three months during the winter.

X Int. 33. Did you have any other occupation at their works during that year?

A. Nothing except, maybe, being in the office at various times to help their work there.

X Int. 34. Was that during these winter months?

A. Yes, sir; during these two or three winter months.

X Int. 35. What other business or businesses were you engaged in during the years 1875, 1876, 1877, and 1878?

A. Nothing in 1875 or 1876. In 1878 I commenced instructing in the Worcester Technical Institute in civil engineering. I think it was in the fall of 1877, but am not sure; also about that time I formed a partnership with Mr. Heald to carry on the jobbing civil-engineer business; devoted little or no time out of the institute hours to that business. The teaching occupied about 15 to 20 hours a week.

331 X Int. 36. You stated that after the 1st of August, 1876, you returned to the said company. How much of your time was devoted to the work of that company during the remainder of the year 1876, and what was the nature of your employment there?

A. All the work that I did for the rest of that year was done for the company, in the office and shop, with a short time at Philadelphia. I was in the shop all the year, except while I was at the Centennial exposition.

X Int. 37. What were your duties in the shop during the latter half of the year 1876?

A. Doing what draughting there was, general office work, and looking out for the shipping.

X Int. 38. What was the nature of the "office work" which you did?

A. It was such as any assistant to a book-keeper would do, looking out for records of meters, tests, put into the proper record books entries in day book, and such work.

X Int. 38. Were your duties the same during the years 1877 and 1878?

A. Yes, sir; practically the same.

X Int. 40. These cuts which you have produced, numbered 1 and 2, are contained in catalogues issued by the Union Water Meter Co. in the years 1883 and 1884, are they not?

A. Yes, sir.

X Int. 41. Am I right in understanding from your testimony that your company is now making and selling the type of meter illustrated in said cuts, and that in such meters about one in 10 have pistons made of hard rubber, the other nine being precisely like them, with the single exception that the pistons are made of bronze instead of rubber?

A. Yes, sir; that proportion would be very close, the
332 remainder being made the same, with the exception of bronze pistons instead of rubber pistons.

X Int. 42. Who first suggested that the pistons be made of hard rubber instead of bronze?

A. I think either Mr. Phineas Bail, the president, or Mr. Benaiah Fitts, our mechanical engineer at that time, the patentee of the meter.

X Int. 43. Was the first meter with a rubber piston that made for exhibition at the Centennial?

A. I cannot say as to the small meters. For the large ones the 8-inch meter was the first one as large that we had ever made.

X Int. 44. About what was the total length and breadth of the case of that 8-inch meter?

A. I should say the smallest diameter would be about 30 to 32 inches; the largest diameter would be about 40 inches.

X Int. 45. And what would be the size of each of the pistons?

A. The height of an 8-inch piston would be about 14 inches; I should think the longest diameter would be about 15 or 16 inches.

X Int. 46. Why was this piston put in a new case when it was taken from the Centennial?

A. Simply for the reason we wished to keep the meter on exhibition at the Centennial. We left the case there without the pistons and put the pistons in the new case.

X Int. 47. Do you know where that particular meter is now, the one sent to the Amoskeag Manufacturing Co.?

A. The body, I suppose, to the best of my knowledge, is still in service; the rubber pistons were removed and bronze pistons put in about two years after it was sold.

333 X Int. 48. What was the reason of replacing the rubber pistons with bronze ones?

A. The cause was the expansion of the rubber.

X Int. 49. Have you in your possession or under your control any water meters of the type under consideration made during the years 1875, 1876, 1877, 1878, with hard-rubber pistons?

A. I do not think we have the meters complete, bodies and pistons, but I think we have rubber pistons bought during that time.

X Int. 50. Is the entry in the day book which you have produced in your own handwriting?

A. No, sir; it is in the handwriting of Mr. John C. Otis.

X Int. 51. Please quote on the record the entire entry at page 170 to which you have referred.

A.—

370. Amoskeag Manufacturing Company, Manchester, Dr.

6.001. To 1 8-in. rotary meter (rubber floats)---------- 1,000

X Int. 52. Where do you find the next entry in that day book indicating the sale of one of these meters having a hard-rubber piston?

A. I cannot say, because hard-rubber pistons or bronze pistons are not and have not been always designated. Our meters are generally designated just rotary piston meters, not specifying the style of piston. In this case the designation was made owing to our sending 5 8-inch meters to the Amoskeag Company, one being with rubber pistons, the other four bronze.

X Int. 53. Are these bills from the Boston Belting Company introduced in evidence all the bills received by your company from said belting company between August, 1875, and April, 1876?

A. No, sir; they are not.

X Int. 54. If you have any other bills with you from said company will you please produce them?

334 A. Yes, sir. I do now produce them. I can't say whether these are all the bills received between the dates specified.

X Int. 55. What is the meaning of the "water meter, rubber or rubbers," employed in these bills?

A. They refer to the rubber floats or pistons used in the rotary piston meters.

X Int. 56. Are you in the habit of designating the pistons in your meters as floats? Is there any other part of the meter ever designated by the same term, "float"?

A. When the meter first commenced to be made the pistons were called floats. For the last few years they are designated and called pistons; no other part of meter has that term.

X Int. 57. Did the Union Water Meter Company during the year 1878 employ a travelling salesman by the name of Mr. Welch?

A. Yes, sir; S. A. Welch.

X Int. 58. When did his employment by that company begin?

A. I should say in the fall of 1868 or spring of 1869.

X Int. 59. You have stated that about one in 10 of your rotary meters now sold have rubber pistons. Why are they not all made with rubber pistons?

A. Because superintendents of water works prefer bronze pistons; some of them.

Redirect examination by F. P. Fish, Esq., of counsel for defendant:

Int. 60. State whether or not the Union Meter Co. sold
335 water meters with hard-rubber pistons as a regular part of its business during the year 1877.

A. Yes, sir; when rubber pistons were asked for.

JOHN P. K. OTIS.

Attest: SIMON G. COGSWELL,
Special Examiner.

At the request of counsel for defendant the magistrate marks the day book referred to in the above deposition for identification:

Circuit court of the United States, southern district of New York. National Water Meter Co. *v.* Board of Water Commissioners of Yonkers. S. G. Croswell, special examiner.

Examination adjourned to Saturday, July 28th, 1888, at 12 a. m.

336 DEFENDANT'S EXHIBIT UNION WATER METER CO., BILL NO. 1. S. G. C., Sp. Ex.

BOSTON, *Aug.* 3, 1875.

Union Water Meter Wks. bought of Boston Belting Company, manufacturers and dealers in rubber belting, steam packing, engine hose, and Indian-rubber fabrics of every description. John G. Tappan & Co., general agents, 189, 191, 193, & 195 Devonshire street and 52, 54, & 56 Arch street.

No claims for errors or defects allowed unless made within ten days from receipt of goods.

Terms cash in Boston current funds.

All goods at risk of purchaser after shipment.

3 hard rubbers, 7 lbs., at	$2 00	$14 00
	Nett.	

1 box.
B. & A. E.

DEFENDANT'S EXHIBIT UNION WATER METER CO., BILL NO. 2. S. G. C., Sp. Ex.

(Same heading as Exhibit Bill No. 1.)

BOSTON, *Sept.* 29, 1875.

2 rubbers in mould at	$1 50	$3 00
	Nett.	

One bdl.
By express.

337 DEFENDANT'S EXHIBIT UNION WATER METER CO., BILL NO. 3. S. G. C., Sp. Ex.

(Same heading as Exhibit Bill No. 2.)

BOSTON, *Feb'y* 22, 1876.

2 water-meter rubbers, 117⁴ lbs., at	$1 50	$175 88
1 box for do.		50
		$176 38

Nett.

Rec'd payment.
Mar. 10, 1876.

BOSTON BELTING CO.,
Per E. UPHAM.

One box.
B. & M.

DEFENDANT'S EXHIBIT UNION WATER METER CO., BILL NO. 4. S. G. C., Sp. Ex.

(Same heading as Exhibit Bill No. 3.)

BOSTON, *March* 8, 1876.

14 small floats at	$1 37	$19 18
Box		30
		$19 48

Nett.

One box.
By express.

338 DEFENDANT'S EXHIBIT UNION WATER METER CO., BILL NO. 5. S. C. G., Sp. Ex.

(Same heading as Exhibit Bill No. 4.)

BOSTON, *M'ch* 16, 1876.

11 floats at	$1 37	$15 07
1 box for do.		25
		$15 32

Nett.

One box.
By express.

DEFENDANT'S EXHIBIT UNION WATER METER CO., BILL NO. 6. S. G. C., Sp. Ex.

(Same heading as Exhibit Bill No. 5.)

BOSTON, *April* 7, 1876.

1 large w. m. rubber, $58\frac{3}{4}$ lbs., at ---------- $1 50 $88 13
Nett.

One case.
By B. & A. R. R.

DEFENDANT'S EXHIBIT UNION WATER METER CO., BILL NO. 7. S. G. C., Sp. Ex.

(Same heading as Exhibit Bill No. 6.)

BOSTON, *April* 18, 1876.

1 w. m. rubber, $58\frac{15}{16}$ lbs., at ---------- $1 50 $88 41
Nett.

One box.
B. R. R.

339 Examination resumed pursuant to adjournment.
Present as before.

Deposition of Lewis H. Nash.

Direct examination by F. P. FISH, Esq., of counsel for defendants:

Int. 1. What is your name, age, residence, and occupation?
A. Lewis H. Nash; 36 years; mechanical engineer; employed by the National Meter Company.
Int. 2. Are you the Lewis H. Nash assignor to the National Meter Company to whom were granted reissued letters patent of the United States No. 10806, on which this suit is brought?
A. I am.
Int. 3. Are you also the Lewis Hallock Nash, the patentee named in letters patent of the United States No. 336,143, dated February 16th, 1886, a copy of which I now show you?
A. I am.

(The copy of the patent No. 336,143 shown the witness is introduced in evidence and marked "Defendant's Exhibit Nash Patent, 336,143, S. G. C., sp. ex.")

Int. 4. In the specification of said patent No. 336,143 you refer to your letters patent No. 211,769, the original of the reissue here in suit, and proceed as follows—I quote from the first column of page 1, beginning at line 30: "In my said patent (original patent No. 211,769) the valve-forming piston has one less number of projections

than the case chamber, while in my present improvement
340 the dividing bearing projections are of equal number in both the piston and the case chamber, which involves a motion of the piston slightly different from that described in my said patent. Such construction of equal number of coacting joint-forming projections I do not claim, broadly, as both water meters and steam-engines have been used having such construction." To what water meters and to what steam-engines did you refer in the last clause of the passage quoted as having that construction?

A. The water meter that I referred to was the Glaskell patent, patent to Harvey Glaskell; I don't know the number. It came out in the early part of 1885, and the steam-engine was the one described in the English (1846) patent to Galloway here in evidence.

Int. 5. When did you first know of the steam-engine of the Galloway (1846) patent?

A. It was at the time I was working upon the series of patents about the date of the one just offered in evidence. It was about the date of the application for that patent (Oct. 19th, 1885).

LEWIS HALLOCK NASH.

Attest: SIMON G. CROSWELL,
Special Examiner.

Deposition of James Bennett Forsyth.

Direct examination by F. P. FISH, Esq., of counsel for defendants:

Int. 1. What is your name, age, residence, and occupation?
341 A. James Bennett Forsyth; 44 years; Boston Highlands, Mass.; rubber manufacturer. I am the manufacturing agent and general manager of the Boston Belting Co.; have also filled the position of superintendent of the factory for many years before being appointed general manager. I was appointed superintendent in the summer of 1861 and manufacturing agent in addition to the position of superintendent in 1866. Those two position- I filled until the spring of 1884, when I partly relinquished the position of superintendent and was appointed general manager of the company, at the same time holding the position of manufacturing agent in addition to the position of general manager.

Int. 2. State whether or not the Boston Belting Company ever to your knowledge did work on rotary water-meter floats or pistons for the Union Water Meter Co. of Worcester, Mass.; and, if so, what was it.

A. We did work for the Union Water Meter Co. and made hard-rubber floats for rotary water meters.

Int. 3. When did you do this work?

A. I cannot give the exact date, but it was from 12 to 15 years ago, I think, since we first commenced to make them.

Int. 4. Do you remember any circumstance that enables you to fix a date when you were making hard-rubber floats for the Union Water Meter Co.?

A. I do remember one circumstance very well. I remember making a float or floats that were to be used in a water meter or water meters that were to be exhibited at the Centennial exposition at Philadelphia. I know that the agent of the Union Water Meter Company called on me at the factory and asked me to take especial pains in the manufacture of these floats, as they were to be used in water meters that were to be exhibited in Philadelphia, at the Centennial exposition.

342 Int. 5. State whether or not the Boston Belting Co. made such hard-rubber floats for the Union Water Meter Co. before and after that time.

A. Yes, sir; we were manufacturing these floats before that order was given and we manufactured some after that time, too.

Int. 6. Look at the cuts "Defendant's Exhibits Cut Union Rotary Piston Water Meter No. 1 and No. 2" and state whether or not you see in those cuts such pistons or floats as you made for the Union Water Meter Co. at that time.

A. The small cut in the center of the three cuts on sheet marked No. 1 shows the floats such as we made—that is, the part underneath the gearing in the cut. The right-hand cut in Exhibit No. 2 also shows the floats such as we made.

Int. 7. Look at the "Exhibits Union Water Meter Co. Bills Nos. 1–7" and state what are the articles therein referred to as "W. M. rubber," "hard rubbers," "floats," "small floats," "water-meter rubbers," and "rubbers in mould," if you know.

A. The bills are from the Boston Belting Co. against the Union Water Meter Co. and are for hard-rubber floats that were made for that company at the time these bills were presented. We made two or more sizes of the floats and the prices varied according to the sizes of the floats and the material used in them.

JAMES BENNETT FORSYTH.

Attest: SIMON G. CROSWELL,
Special Examiner.

343 Counsel for defendants introduces in evidence a copy of British letters patent to Elijah Galloway, No. 9744 of 1843, and the same is marked "Defendant's Exhibit Galloway 1843 Patent (propelling vessels), S. G. C., sp. ex."

Defendant's counsel also offers in evidence a certified copy of the file-wrapper and contents of the application on which the reissued letters patent in suit were granted, and the same is marked "Defendant's Exhibit File-Wrapper and Contents, Nash Reissue, S. G. C., sp. ex."

Deposition of James A. Tilden.

Direct examination by F. P. FISH, Esq., of counsel for defendants:

Int. 1. What is your name, age, residence, and occupation?

A. James A. Tilden; 25 years; Hyde Park, Mass.; am superintendent of the Hersey Meter Company.

Int. 2. Are you familiar with the practical operation of the Hersey meter, alleged by the complainants to infringe the Nash reissue here in suit, and the Crown meter manufactured by the complainants under said reissue and with the other forms of water meters that are and have been in general use? If so, what is the extent of your acquaintance with those meters and for how many years have you been familiar with them?

A. I am familiar with the operation of all the principal meters in the market at the present time. I have personally made experiments with all or nearly all of them, and have observed their operation in many cities which I have visited on the water-meter business during the last 8 years. I have conducted experiments
344 upon water meters from time to time since the fall of 1880, and have been a frequent visitor to the meter-testing rooms of various water departments since that time. I would add that I am specially familiar with the meters specified in the question.

Int. 3. Have you read the Nash reissue here in suit, and do you understand the practical operation of the meters therein shown and described?

A. I have read the reissue frequently and think I understand the operation of the meters described.

Int. 4. What connection, if any, have you had with designing and manufacturing the Hersey meter?

A. I am the designer or inventor of the Hersey meter and have had charge of its manufacture.

Int. 5. State whether or not you have obtained any letters patent on the said Hersey meter. If so, produce copies of them to be marked as exhibits in this case.

A. I have obtained several patents on the Hersey meter and produce in evidence copies of the same.

Copies produced by the witness are introduced in evidence and marked respectively "Defendant's Exhibit Tilden Original Patent of 1885, S. G. C., sp. ex.; Defendant's Exhibit Tilden Reissue, S. G. C., sp. ex., and Defendant's Exhibit Tilden Original Patent of 1887, S. G. C., sp. ex."

Int. 6. What was your purpose in inventing the meter known as the Hersey meter?

Question objected to as irrelevant, incompetent, and immaterial.

345 A. It was to overcome certain defects which were popularly believed to exist in rotary meters then in the market. I refer particularly to the liability to stoppage from small particles of foreign matter ordinarily carried along by the water; also it was to design a meter which will be self-compensating for wear. The pistons of rotary water meters made up to that time would wear rapidly, especially in waters containing a destructive sediment, and there was no provision for taking up this wear. The piston of the Hersey meter is so designed with reference to its cylinder that it is self-compensating and will wear tight.

Int. 7. When did you first complete a Hersey meter, and when were such meters first introduced into the market? State also, generally, the extent to which they have been introduced up to the present time.

A. I think the first Hersey meter was made in November, 1884. I am unable to fix the date exactly, but I see that my application was filed in December of that year, and I know it was some time previous. A few meters were sent out in the fall of 1885. Altogether about three hundred and eighty were sent out up to December, 1886. I will add that these meters were distributed among some eighty cities and towns. Up to the present time there has been sent out about twenty-five hundred meters, distributed among over three hundred cities and towns of the United States.

Int. 8. How successful have the Hersey meters proved themselves to be in practical operation, generally speaking, and also with reference to the special qualities which you undertook to embody in them, as stated in your answer to interrogatory 6?

A. The meter has proved itself to be very successful, meeting in a practical manner all the requirements of a water meter. It has been specially successful in waters containing a heavy sedi-
346 ment, such as the Western river waters, and the freedom from stoppage by such sediment and its durability under such conditions is particularly noticeable.

Int. 9. Have tests been made as to the operation of the Hersey meter; if so, are you able to produce any such tests that were made by yourself or others?

A. I produce in evidence a letter from the Lexington Hydraulic and Manufacturing Co. of July 8th, 1886, together with the sheet of tests.

Letter and sheet introduced in evidence and marked "Defendant's Exhibit Lexington Letter and Sheet of Tests Hersey Meter, S. G. C., sp. ex."

Int. 10. How do the tests recorded in the exhibit just produced agree with other tests, if any, that have been made of the Hersey meter?

A. It may fairly be said to be a representative test of all the Hersey meters.

Int. 11. State whether or not you took any precautions while devising the Hersey meter to avoid the use in that meter of devices that were secured to other persons by letters patent then existing.

A. Prior to the invention of the Hersey meter I had invented and patented several water meters and had applied for patents on still others. Finding these applications rejected by references to the state of the art, I determined before proceeding further to obtain a complete set of the patents on water meters issued to that time, and I did obtain from the Patent Office the entire class of water meters. I think this was some time in 1883, and I made many careful examinations of all the patents in that class, and in designing the
347 Hersey meter I endeavored to make it free from infringement in every particular according to the best of my knowledge on those matters.

Int. 12. Had you advertised the Hersey meter prior to December 18th, 1886; and, if so, how extensively?

A. The Hersey meter was advertised prior to that time in the Journal of the New England Water Works Association and, I think, in other publications which were circulated among water departments. Circulars had also been sent out to every water department in the United States at various times. The company was also known as Associate Members of the Water Works Association.

(All the questions and answers after the answer to interrogatory 6 objected to as incompetent, irrelevant, and immaterial. The objection is entered here by consent of defendant's counsel.)

Int. 13. Describe the arrangement of the ports in the Hersey meter, which is represented by Complainant's Exhibit D in this case, and the function and mode of operation of those ports in connection with the moving piston.

A. The ports of the Hersey meter are in the end plates or heads of the cylinder. The inlet ports are the six large holes in and extending through the bottom plate, and are located at one side of each of the recesses in the cylinder. These ports are on the same relative side of each recess.

The outlet ports are in both end plates. Those in the top plate are simply duplicates of those in the bottom plate, and are arranged in such a manner as to be exactly opposite to them. These outlet ports are on the opposite side of each recess from the large
348 inlet holes referred to, but, unlike the inlet ports, they do not extend through the plate. Each outlet port consists of two holes, which, as said before, do not extend through the plate, but are connected with each other by a passage within the plate itself. In describing the operation of the piston as it passes over these ports it will be unnecessary to consider the top plate. As I have stated before, the ports in the top plate are duplicates of the outlet ports in the bottom plate. Now, placing the piston in the cylinder and in contact with the walls thereof, with the top plate removed, it will be seen that there is an opening through the bottom plate at the same relative side of each projection of the piston which is in contact with the cylinder, and that there is an outlet port exposed on the opposite side of each of these projections. When I speak of a projection as being in contact with the cylinder, I mean that there is a contact on both sides of the projection of the piston. The outlet ports in the plates are opened by the passage of the circular opening in the centre of the piston, and it will be seen that when a projection of the piston is in what I have described as double contact with the cylinder the outlet water can escape down through one of the pair of outlet ports described above and will pass through the passage in the plate and up into the hole of the piston which at that time uncovers it. Now, as the water has an opportunity to come in at the same relative side of each projection and can pass out from the opposite side, the piston must move in a direction away from the inlet holes and towards the exhaust ports. Moving the piston in this

direction, it will be seen that it performs the function of a valve, in that it opens and closes these ports. It opens the outlet ports in succession at the moment of double contact of the projection, allowing the water to escape from a cavity
349 so formed. Each recess of the cylinder is thus divided into two cavities, one filling and the other discharging. In designing the Hersey meter I observed that I would have to arrange the ports in such a manner as to perform a function not found in rotary meters as far as I knew at that time, as I did not know of the existence of the Galloway patent and that its valve performed this function, which I will now describe. The piston of the Hersey meter, being perfectly loose in its case, required an arrangement of ports so as to keep the piston in contact with the walls of the cylinder; otherwise the piston will not perform its duty in displacing water. When the piston is in such proper contact there are formed several spaces, which, by the arrangement of the ports described, are open to the outlet. There is consequently less pressure in these spaces than those open to the inlet. Now, by arranging the inlet ports in such a way that there shall be a free access of the water to all that part between the piston and cylinder not measuring water, I was enabled to obtain an excess of pressure which would tend to keep the piston against the wall of its cylinder at every point in its revolution.

This pressure is what may be termed lateral pressure, in that it is at right angles to the direction of the piston's movement. I have now described this special and peculiar function of the piston. The piston not only opens and closes the inlet and outlet ports, as is common in rotary meters, but performs a third duty of opening the ports in such a way as to produce the lateral pressure above referred to.

I will add that the water escapes from the central hole in the piston up through the central hole in the top plate, to which it is always open.

X Int. 14. Is it possible to run either the Hersey meter or the meter of the Nash reissue backward—that is, in the opposite direction to the normal?

350 A. Yes, as to the Nash meter, as the reissued patent states; as to the Hersey meter, no, because that part of the piston which is exposed to the lateral pressure described, tending to keep the piston against the side, will, by the reversal of the ports, be open to the outlet, which will tend to throw the piston away from the side of the case.

X Int. 15. Mr. Brevoort has testified that "engines are not adapted without certain changes to act as meters, and to adapt old engines and turn them into practical water meters for commercial use furnishes a broad field for invention." From your experience in inventing and building meters do you agree with Mr. Brevoort?

A. I do not agree with Mr. Brevoort as to the last statement. It is true that to adapt an engine to the purposes of a meter certain changes in proportioning of the parts have to be made, but such changes have long been known and used, are very simple, and do

not require invention. It is desirable that the moving parts shall be light, the ports large, and the connection with the registering mechanism no heavier than is necessary to perform the work of driving the clock. I think these few rules would enable one skilled in the art to convert almost any engine into a meter.

Cross-examination by J. E. BULL, Esq., of counsel for complainants:

X Int. 16. Why do you not make both the cylinder and piston of the Hersey meter of metal, such as brass?

A. It is very much more expensive to make it in that way.

X Int. 17. Any other reason?

351 A. I do not think brass would be as durable; no other reason; it is purely a question of cost.

X Int. 18. Does the piston of your meter and the case in actual use wear down evenly all round?

A. The wear of the piston and case is so very slight even under the most trying conditions that it is impossible to say. I do know, however, that the fit of the piston is improved by use.

X Int. 19. I place in your hands letters patent No. 385,970, granted to you July 10th, 1888. Are you the inventor of the device covered by that patent and are the statements contained therein true?

A. I am the inventor of that device and believe the statements contained to be true.

Patent put in evidence and marked Exhibit Tilden 1888 Patent, S. G. C., sp. ex.

X Int. 20. Are the statements contained in the three patents granted to you and offered in evidence this morning true?

A. I think so. I have not read them or either of them recently.

X Int. 21. Does not the piston of the Hersey meter stand eccentrically with relation to its case during the whole time that it is in operation?

Objected to as not opened by the direct examination.

A. Not as I understand the definition of the word as given by Mr. Renwick. I should say no.

X Int. 22. Do you know whether or not it was the practice of the examiner in the Patent Office having charge of meter appli-

352 cations to cite steam-engines as references thereto up to the time your orginal patent was granted?

Question objected to as incompetent, irrelevant, and immaterial.

A. I don't know.

X Int. 23. How many meters have the Hersey Meter Company sold?

A. I should say very nearly all those I have referred to as sent out.

X Int. 24. I place in your hands a copy of the Engineering News and American Contract Journal of December 25th, 1886. Did you

write the article contained on pages 427, 428 of that Journal and are the statements contained therein true?

A. I did write the article, and at the time I wrote it I believed the description of experiments to be correct.

Article put in evidence by complainant's counsel and marked "Exhibit Tilden Article, S. G. C., sp. ex."

X Int. 25. Was it read by you before the Boston Society of Civil Engineers on or about November 17th, 1886?

A. It was.

X Int. 26. Did you at the time it was read believe it to be true?

A. As it was written about the time it was read, the answer to interrogatory 24 is right. I don't see anything but what I believed to be true at the time.

X Int. 27. If you can, state when you first became aware of the existence of the Galloway 1846 patent.

A. Some time in May, I think, of 1886.

353 Redirect examination by F. P. FISH, of counsel for defendants:

Int. 28. Is the relative lightness of metal and hard-rubber material — in selecting which shall be used as a meter piston?

Objected to as leading.

A. Both can be used equally well.

Int. 29. Which is the lighter of the two?

A. Hard rubber.

Int. 30. Is there any advantage in the use of hard rubber because it is lighter?

A. In some meters, yes, and in some, no.

Int. 31. How is it in your own meter?

A. It is of no advantage except as a question of cost.

JAMES A. TILDEN.

Attest: SIMON G. CROSWELL,
Special Examiner.

354 DEFENDANT'S EXHIBIT LEXINGTON LETTER AND SHEET OF TESTS HERSEY METER. S. G. C., Sp. Ex.

Circuit Court of the United States, Southern District of New York.

NATIONAL METER COMPANY
vs.
BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS.

Office of the Lexington Hydraulic and Manufacturing Company, No. 5 Cheapside.

LEXINGTON, KY., *July 8th*, 1886.

Hersey Meter Co., Boston, Mass.:

I send herewith a list of tests made of one of your ½-inch meter and I think it proper to say that I am agreeably surprised at t

result, its accuracy being far greater than I had imagined to be possible.

The reachings of the meter were only taken to even cubic feet, as we did not anticipate such close results, and I have therefore interpolated by calculation the fractional readings of the meter for each pressure, but, of course, as it is not probable that the 355 hands slipped on even C. ft. these fractions are only approximate, and we can only certainly rely on the grand totals, which show a difference of only 2.57 C. ft. in 33 tests at pressures from 20 to 90 lbs., with outlets from $\frac{1}{8}$ to $\frac{4}{8}$ inches in periods varying from from 5 to 95 minutes tests, probably far more severe than will ever be made in actual use.

In test No. 1 the water was drawn off entirely by the bucketfull, thus repeatedly stopping and starting the meter, and — all the tests marked "intermittent" the same was true to a lesser extent.

We noticed especially its non-liability to stoppage from obstructions. We tested with pieces of grass and paper, but the meter continued to revolve and record correctly.

(The only point now on which I wish information is this: The Crown meter manufacturers claim that your meter is an infringement on their patent, and I request you to send me a copy of their patent and your own, that I may compare your respective claims and judge somewhat as to our risk in using your meter.)

I have ordered by telegraph five of your meters ($\frac{1}{2}$ inch).

This order is on the condition that your meter is not an infringement on the Crown meter patent, and is given in advance of an examination of your respective patents because I need some for immediate use and cannot wait the result of the examination.

If on such examination it appears that your meter does not infringe, I have no hesitation in saying that my present preferences are decidedly in its favor.

Very respectfully, S. A. CHARLES, *Sup'd't.*

356 *Tests of the Hersey Meter (½ Inch).*

Test. No.	Readings. Meter.	Meter.	Differences. Meter.	Meas'd.	lbs.	Size outlet.	Time running—minutes.	Remarks.
1	249	262	13	13.44	30	⅛ in.	18	Intermittent use.
2	262	275	13	13.44	"	3/16 "	73	" "
3	275	288	13	13.44	"	¼ "	12	" "
4	288	302	14	13.44	"	5/16 "	10	" "
5	302	315	13	13.44	"	⅜ "	6	Full capacity.
6	315	328	13	13.44	20	⅛ "	30	Intermittent use.
7	328	341	13	13.44	"	3/16 "	12	" "
8	341	355	14	13.44	"	¼ "	10	Full capacity.
9	355	368	13	13.44	"	5/16 "	95	Intermittent use.
10	368	382	14	13.44	40	⅜ "	7	Full capacity.
11	382	395	13	13.44	"	⅛ "	8	Intermittent use.
12	395	408	13	13.44	"	3/16 "	15	" "
13	408	422	14	13.44	"	¼ "	31	" "
14	422	435	13	13.44	50	5/16 "	17	" "
15	435	449	14	13.44	"	⅜ "	15	" "
16	449	462	13	13.44	"	⅛ "	8	Full capacity.
17	462	475	13	13.44	"	3/16 "	9	Intermittent use.
18	475	489	14	13.44	60	¼ "	6	Full capacity.
19	489	502	13	13.44	"	5/16 "	8	Intermittent use.
20	502	516	14	13.44	"	⅜ "	12	" "
21	516	529	13	13.44	"	⅛ "	14½	" "
22	529	543	14	13.44	70	3/16 "	5	Full capacity.
23	543	556	13	13.44	"	¼ "	6½	Intermittent use.
24	556	569	13	13.44	"	5/16 "	10	" "
25	569	583	14	13.44	"	⅜ "	12½	" "
26	583	596	13	13.44	80	⅛ "	5	Full capacity.
27	596	609	13	13.44	"	3/16 "	6	Intermittent use.
28	609	623	14	13.44	"	¼ "	12	" "
29	623	636	13	13.44	"	5/16 "	25	" "
30	636	650	14	13.44	90	⅜ "	5	Full capacity.
31	650	663	13	13.44	"	⅛ "	20	Intermittent use.
32	663	676	13	13.44	"	3/16 "	16	" "
33	676	690	14	13.44	"	¼ "	69	" "
			441	443.57				

13.20 ar. 13.25 × 13.50 × 13.25 × 13.50 × 13.25 × 13.50 ×

Weight of water for each test, 837 lbs.= 13.44 × C. ft.
Total weight, 33 tests, 27,621 " =443.57 "
Assumed weight of a cubic foot at 75 deg., 62.27 lbs.

357 DISTRICT OF MASSACHUSETTS, *Suffolk*, } *ss:*

I, Simon G. Croswell, of Boston, Massachusetts, being duly authorized, by agreement pursuant to the 67th rule of the Supreme Court of the United States in equity, as amended, to take the evidence of the defendants in the case of The National Meter Company *vs.* The Board of Water Commissioners of the City of Yonkers, now pending in the circuit court of the United States for the southern district of New York, certify that on the days mentioned in the foregoing evidence I was attended at 40 Water street, room 55, Boston, Suffolk county, district of Massachusetts, by the counsel

the respective parties, and by the witnesses, to wit, John P. K. Otis, Lewis H. Nash, James Bennett Forsyth, and James A. Tilden; that each of said witnesses was by me duly sworn and did thereupon depose as appears in their respective depositions, which depositions were reduced by me to writing in the presence of said witnesses and read to them and signed severally by them as and for their depositions.

And I further certify that I am not of counsel or attorney to either of the parties in said cause nor in any way interested in the event thereof, and that in taking said evidence I have in all respects complied with the 67th rule in equity, as amended, of the Supreme Court of the United States, and I herewith transmit said evidence under my seal to the clerk of the court in which said cause is pending.

In testimony whereof I have hereunto set my hand and seal this 28th day of July, 1888.

[SEAL.] SIMON G. CROSWELL,
Notary Public.

358 At a stated term of the circuit court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Tuesday, the 26th day of February, in the year of our Lord one thousand eight hundred and eighty-nine.

Present: The Honorable William J. Wallace, circuit judge.

THE NATIONAL METER COMPANY
vs.
THE BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS.

The above cause coming on for final hearing upon pleadings and proofs—

Mr. I. Edgar Bull is heard in behalf of complainant.

Further argument adjourned to the 28th inst.

359 At a stated term of the circuit court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Thursday, the 28th day of February, in the year of our Lord one thousand eight hundred and eighty-nine.

Present: The Honorable William J. Wallace, circuit judge.

THE NATIONAL METER COMPANY
vs.
THE BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS.

The argument in the above cause being resumed pursuant to adjournment—

Mr. Bull continues his argument in behalf of complainant.

Mr. Frederick P. Fish is heard in behalf of defendant.

Adjourned to Monday, March 4th, 1889.

360 At a stated term of the circuit court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Monday, the 4th day of March, in the year of our Lord one thousand eight hundred and eighty-nine.

Present: The Honorable William J. Wallace, circuit judge.

THE NATIONAL METER COMPANY
vs.
THE BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS.

The argument in the above cause being this day resumed pursuant to adjournment—

Mr. Fish concludes his argument in behalf of defendant.

Mr. George C. Roberts is heard in behalf of defendant.

Mr. Bull closes in behalf of complainant.

Curia advisari vult.

361 United States Circuit Court, Southern District of New York.

NATIONAL METER COMPANY
vs.
BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS.

WALLACE, *J.:*

This suit is brought to restrain infringement of claims 3, 4, 5, and 6 of reissued letters patent granted to the complainant as assignee of Lewis H. Nash February 8, 1887, for an "improvement in rotary water meters." The original patent (No. 211,582) was granted January 21, 1879. None of the claims now in controversy were contained in the original patent. The alleged infringing apparatus of the defendants is constructed under patents granted to James A. Tilden, assignor to Hersey Brothers, for "rotary fluid meters," the first of which was granted August 18, 1885. The manufacture of the alleged infringing meters was commenced and quite a large number of them put upon the market and they were extensively advertised prior to the filing of the application for the reissue of the complainant's patent. The defenses are non-infringement and the invalidity of the reissue as to the claims in controversy.

362 The experts on both sides agree that Nash, the inventor of the complainant's water meter, took one form of the Galloway rotary engine described in Reuleaux's Kinematics of Machinery (translation of Alex. B. Kennedy, published in London in 1876), and made improvements upon it which were necessary to adapt it for practical use as a water meter, and these improvements were meritorious and valuable. At that time it was well known that steam and water engines, whether rotary or reciprocating, could be used as meters to measure the flow of the fluids which pa through them, and various forms of both descriptions had been u as meters. The patent of Nash states that it is contemplated to the apparatus as a motor (engine) or as a pump. Besides the r

engine thus described Galloway patented another form of engine (English patent to Galloway of December 14, 1847). The experts agree that Tilden, the inventor of the defendant's water motor, took the form of the Galloway engine of this patent and made improvements upon it which were necessary to adapt it to practical use as a water meter.

What each did was to supply the arrangements of ports and discharging spaces necessary for the special form of piston and cylinder chamber employed in the respective Galloway engines in order to convert the engine into a practical water meter, adding also a registering device to operate by attachment to the piston. In the Kinematic engine there is a piston with projection and a cylinder with recesses, but the recesses of the cylinder are more in number
363 than the projections of the piston, while in the engine of the Galloway patent the piston has the same number of projections as the cylinder has recesses. In the Kinematic engine the piston has a side-rocking movement across the centre of the cylinder upon successive bearing points made by the contact of a projection on the piston with a recess in the cylinder or conversely, and the piston rotates upon its own axis so that each projection visits successively each recess of the cylinder, while the piston of the Galloway engine has neither the side-rocking nor the rotary motion, and each projection of the piston always operates in connection with one particular corresponding recess in the cylinder and never leaves that recess.

The description of the apparatus of the complainant's patent is precisely the same in the original and in the reissue. In the reissue, however, there is a disclaimer of the combination of elements shown in the Galloway patent. In the original patent all the eight claims except the first were for combinations in which a piston revolving about its centre was an element.

The disclaimer of the reissue seems to have been inserted upon the theory that the first claim of the original did not specify such a piston and was sufficiently broad to include the combination of the Galloway patented engine. The new claims in the reissue were doubtless intended to cover inventions of which this combination is a part. Although the language of the first claim did not ex-
364 pressly specify such a piston, it does not seem open to fair doubt that such a piston was a necessary element of that claim.

A brief reference to the language of the specification suffices to show that such a piston was a necessary element of the first claim of the original patent and must be read into and all the new claims of the reissue now in controversy.

The piston is described in the specification as "adapted to have an eccentric or side-rocking motion across the centre of a cylinder chamber, to affect its division at two or more points into receiving and discharging spaces. * * * With this eccentric or side-rocking action the piston also revolves around its own centre, and both movements are effected by the relative shape of the piston and cylinder and by the direct action of the water upon the piston,

for, as the piston rocks from one bearing point to another directly across the centre of the cylinder, it is at the same time revolved to effect the measurement of the water passing into and from the cylinder spaces. * * * The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses and projections of such form or configuration as to allow of the rotation of the piston, not only upon its own axis, but around and across the centre of the cylinder, and the space within the cylinder must be of such form and sufficiently larger than the piston to allow it to have
365 this compound motion. * * * The compound motion of the piston and the contacting dividing points are due to the fact that the piston has one or more less points of projection than the cylinder. * * * The function of the valve is to regulate the flow of water in and out of the spaces of the cylinder in such manner as to produce the compound rotation and cross-movement of the piston, and this function can be made operative whether the valve be arranged within the piston as described or separate from and connected with it, it being only necessary that the motion of the valves should be controlled by the compound motion of the piston in any arrangement. * * * I have described that the piston shall have the compound motion described, but it is obvious that the piston may be fixed and the cylinder made to have the relative compound motion."

The only piston described in the specification, and consequently the only one which could have been referred to in the first claim of the original, is one having the side-rocking and rotating movement which constitutes the compound motion of the specification, and is due to the fact that the piston has one or more less points of projection than the cylinder. Unless such a piston is an element of each of the new claims of the reissue now in controversy the reissue as to those claims must be held to be invalid. The defendant's meter does not have such a piston, and therefore does not infringe any of the claims.

366 It is insisted for the complainant that the Galloway Kinematic engine and the Galloway patented engine were well-known equivalents for each other, and that Tilden merely added to the latter the auxiliary devices added to the former by Nash. This proposition does not seem to be correct. The two forms of the Galloway engine are essentially different and necessitate a different construction and arrangement of the co-operating devices to adapt them to efficient use as water meters. The inventions of Nash and Tilden commence upon different lines and result in a combination having a different mode of operation. The time and order of controlling the valves differ in each, and requires a different arrangement of the valve ports with reference to the valves which open and close them. In Nash's meter the ports for both entrance and discharge of water are in the ends or sides of the piston, while in Tilden's the ports are not in the piston, but in the ends or heads of the cylinder case, and are so located that the contact of the piston with the cylinder divides each recess into one filling and one discha

passage. In the former the ends of the cylinder act as the valves; in the latter the piston itself acts as the valves. In Nash's meter the rotary and side rocking or compound movement of the piston opens some and closes others of the ports in succession in such a manner as to equalize the pressure of the water at right angles to the direction of the movements of the piston. In Tilden's
367 meter it is an essential feature that there shall be not merely water pressure which moves the piston about the cylinder chamber, but additional side pressure, which, in Nash's meter, must be avoided, and it is only because it has a pressure of water not found in Nash's meter that it is operative at all.

It is unnecessary to dwell upon the other differences between the two meters which might be pointed out. It suffices to say that, notwithstanding the very ingenious exposition of the expert and counsel for the complainant, the theory that the two meters embody the same combination cannot stand.

The bill is dismissed.

(Endorsed:) United States circuit court, southern dist. of N. Y. National Meter Co. *vs.* Board of Water Commissioners for the City of Yonkers. Opinion. Wallace, J. U. S. circuit court. Filed Apr. 18, 1889. John A. Shields, clerk.

368 At a stated term of the circuit court of the United States for the second circuit and southern district of New York, held at the city of New York, in said district, on the 28th day of June, A. D. 1889.

Present: The Honorable Wm. J. Wallace, judge.

THE NATIONAL METER COMPANY
vs.
THE BOARD OF WATER COMMISSIONERS FOR THE CITY OF YONKERS.

This case having come on to be heard on pleadings and proofs at the said term of said court, and J. Edgar Bull, Esq., having been heard for the complainant, and George L. Roberts, Esq., and Frederick P. Fish, Esq., for the defendant:

Now, therefore, on due consideration thereof, it is hereby—

Ordered, adjudged, and decreed that the bill of complaint herein be, and the same hereby is, dismissed, with costs to the defendant, which have been taxed at the sum of $490.20, and that the defendant have execution therefor.

WM. J. WALLACE.

(Endorsed:) Circuit court of the United States, southern district of New York. The National Meter Company *vs.* The Board of Water Commissioners for the City of Yonkers. Final decree. Livermore & Fish, def't's sol'rs, Boston, Mass.

369 United States Circuit Court, Southern District of New York.

NATIONAL METER COMPANY
vs.
BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS. } In Equity.

It is hereby stipulated and consented that an order may be entered in the above-entitled cause directing the clerk of this court to transmit to the Supreme Court of the United States along with and as part of the record and transcript in this cause the following original paper exhibits, to wit, Complainant's Exhibits D E, F G, and H I and Defendant's Exhibit File-Wrapper and Contents Nash Reissue, and that the same be certified by him as the originals on file.

And it is further stipulated and consented that an order may be entered directing the said clerk to retain in his custody until requested by counsel for either party to transmit the same to the said Supreme Court all the wooden, metal, rubber, and other model exhibits, and that said exhibits be by him before the hearing of this cause on appeal transmitted to the said Supreme Court, and that each be certified by him as the original on file.

N. Y., 8 August, 1889.

BROADNAX & BULL,
Complainant's Sol'rs.
FREDERICK P. FISH,
Sol'r for Def'ts.

370 (Endorsed:) U. S. circuit court, south'n dist. N. Y. National Meter Co. *vs.* Board of Water Com'rs of City of Yonkers. Order, stipulation. Broadnax & Bull, comp't's sol'rs, 120 Broadway, N. Y. U. S. circuit court. Filed Aug. 14, 1889. John A. Shields, clerk.

371 At a stated term of the circuit court of the United States of America for the southern district of New York, held at the United States court-rooms, in the city of New York, on the 14th day of August, in the year of our Lord one thousand eight hundred and eighty-nine.

Present: The Honorable E. Henry Lacombe, judge.

NATIONAL METER COMPANY
vs.
BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS. } In Equity.

On the annexed stipulation and consent and on motion of Messrs. Broadnax & Bull, solicitors for the complainant—

It is ordered that the clerk of this court transmit to the Supreme Court of the United States and along with and as part of the record and transcript in this cause the following original paper exhibits, to wit, Complainant's Exhibits D E, F G, and H I and Def[illegible]

ant's Exhibits File-Wrapper and Contents Nash Reissue, and that the same be certified by him as the originals on file.

And it is further ordered that the clerk of this court retain in his custody until requested by counsel for either party to transmit the same to the said Supreme Court all the wooden, metal, rubber,
372 and other model exhibits, and that such exhibits be by him, before the hearing of this cause on appeal, transmitted to the said Supreme Court, and that each be certified by him as the original on file.

E. HENRY LACOMBE.

373 United States Circuit Court, Southern District of New York.

NATIONAL METER COMPANY, Complainant,
vs.
THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, Defendant. } In Equity.

To the honorable the Supreme Court of the United States:

The appeal of The National Meter Company, the above-named complainant and appellant, respectfully showeth—

That upon the second day of April, A. D. 1888, the above-named complainant filed its bill of complaint in the circuit court of the United States for the southern district of New York against the above-named defendant, alleging that before the fourth day of September, 1878, Lewis H. Nash was the first, original, and sole inventor of a new and useful improvement in rotary water meters, for which letters patent numbered 211,582, dated January 21, 1878, were granted to complainant as assignee of said Nash; also alleging that said letters patent were subsequently discovered to be invalid and inoperative by reason of the patentee claiming as his own
374 invention more than he had a right to claim as new, which errors arose by inadvertence, accident, or mistake and without and fraudulent or deceptive intention; whereupon said letters patent were surrendered and new and limited letters patent were issued to complainant as assignee of said Nash, said reissued patent being numbered 10803, dated February 5th, 1887, and charging defendant with having wrongfully infringed said reissued patent owned by complainant as aforesaid, and praying for a perpetual injunction against said defendant and an accounting.

That subpœnas were duly issued on said bill and duly served.

That said defendant duly appeared, by its solicitors, Messrs. Livermore & Fish, and filed its answer, denying all the material allegations of the said bill.

That on or about the twenty-fourth day of April, 1888, complainant duly filed its replication to said answer.

That thereafter testimony was duly taken for both sides, and thereafter and at the October term, 1889, of said court this cause came on to be heard on the pleadings and proofs and all proceedings therein and was argued by counsel, and thereafter his honor William J. Wallace, circuit judge, before whom the said cause was

argued, rendered his decision in said cause, wherein he dismissed the said bill of complaint, with costs, on the ground that defendant did not infringe said reissued letters patent.

375 That thereafter a final decision was entered herein in favor of the defendant, dismissing the said bill and awarding costs against the complainant.

Wherefore this appellant appeals from the whole of said decree of said circuit court of the United States and respectfully prays that the decree of said circuit court and the bill, answer, pleadings, depositions, evidence, exhibits, and proceedings in the said cause may be sent to the Supreme Court of the United States without delay, and that the Supreme Court will proceed to hear the said cause anew, and that the said decree of the circuit court and every part thereof may be reversed and a decree made sustaining the said bill, and also that defendant may be required to account for and pay to complainant the profits it has derived from said infringement and the damages it has caused complainant by reason of said infringement, and also the costs of this complainant in this cause and on this appeal, and that the defendant may be perpetually enjoined and restrained from using said invention, and that such other and further decrees may be made as to the said Supreme Court may seem just.

Dated this 9th day of July, A. D. 1889.

AMOS BROADNAX,
J. EDGAR BULL,
Solicitors & of Counsel.

The foregoing appeal allowed July 10, 1889.
CHAS. L. BENEDICT.

376 [Endorsed:] U. S. circuit court, southern district of New York. National Meter Co., comp't & appellant, *vs.* Board of Water Commissioners of the City of Yonkers, def't and appellee. Copy. Appeal. Due service of the within appeal is hereby admitted the 21st day of August, A. D. 1889. Livermore & Fish, solicitors & of counsel for respondents. U. S. circuit court. Filed Sept. 20, 1889. John A. Shields, clerk. Broadnax & Bull, comp't's sol'rs, 120 B'way, N. Y.

377 Circuit Court of the United States of America for the Southern District of New York, in the Second Circuit.

NATIONAL METER COMPANY, Complainant and Appel-ant,
vs.
THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, Defendant and Appellee.

Bond for Damages and Costs.

Know all men by these presents that we, The National Meter Company and John L. Lawrence, of # 35 Liberty St., New York, are held and firmly bound unto the above-named defendant and appellee in the sum of nine hundred and eighty $\frac{40}{100}$ dollars, to be paid

the said defendant and appellee; for the payment of which, well and truly to be made, we bind ourselves and each of us, our and each of our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Sealed with our seals and dated the eight- day of July, in the year of our Lord one thousand eight hundred and eighty-nine.

Whereas the above-named complainant an- appellant has prosecuted an appeal to the Supreme Court of the United States in the above-entitled cause of The National Meter Company against The Board of Water Commissioners of the City of Yonkers to reverse the decision and decree rendered in the above-entitled suit by the judge of the circuit court of the United States for the southern district of New York:

Now, therefore, the condition of this obligation is such that if the above-named complainant and appellant shall prosecute its appeal to effect and answer all damages and costs if it shall fail to make its said appeal good, then this obligation shall be void; otherwise the same shall be and remain in full force and virtue.

NATIONAL METER CO.,
By JOHN E. KELLEY, *Pres't.* [L. S.]
JOHN L. LAWRENCE. [L. S.]

Sealed and delivered and taken and acknowledged this 8th day of July, 1889, before me—

[L. S.] JAMES M. TULLY,
Notary Public, New York County.

378 [Endorsed:] U. S. circuit court, southern district of New York. National Meter Company, comp't & appellant, *vs.* The Board of Water Commissioners of the City of Yonkers, def't & appellee. Bond for damages — costs on appeal. The within bond approved as to form and sufficiency of surety. July 10, 1889. Chas. L. Benedict. Broadnax & Bull, comp't's sol's, 120 Broadway, New York. U. S. circuit court. Filed July 10, 1889. John A. Shields, clerk.

UNITED STATES OF AMERICA,
Southern District of New York, City & County of New York, } *ss.:*

John L. Lawrence, being duly sworn, deposes and say- that he resides at Lawrence, Queens county and State of New York; that he is worth the sum of nine hundred and eighty and $\frac{40}{100}$ dollars over and above all his just debts and liabilities.

JOHN L. LAWRENCE.

Sworn to this 8th day of July, A. D. 1889, before me—

[L. S.] JAMES M. TULLY,
Notary Public, New York County.

379 By the Honorable —— ——, one of the judges of the circuit court of the United States for the southern district of New York.

To the Board of Water Commissioners of the City of Yonkers:

Whereas the National Meter Company of New York has lately appealed to the Supreme Court of the United States from a decree lately rendered in the circuit court of the United States for the second circuit and southern district of New York made in favor of you, the said Board of Water Commissioners of the City of Yonkers, and has filed the security required by law, you are therefore hereby cited to appear before the said Supreme Court, at the city of Washington, D. C., on the second Monday of October, 1889, to do and receive what may appertain to justice to be done in the premises.

Given under my hand, at the city of New York, in the second circuit and southern district of New York, the tenth day of July, 1889, in the year of our Lord one thousand eight hundred and eighty-nine.

CHAS. L. BENEDICT.

380 [Endorsed:] U. S. circuit court, southern district of New York. National Meter Co., comp't & appellant, *vs.* Board of Water Commissioners of the City of Yonkers, def't & appellee. Copy. Citation. Appeal. Due service of the within citation is hereby admitted the 21st day of August, A. D. 1889. Livermore & Fish, solicitors & of counsel for respondents. U. S. circuit court. Filed Sept. 20, 1889. John A. Shields, clerk. Broadnax & Bull, comp't's sol'rs, 120 Broadway, N. Y.

381 UNITED STATES OF AMERICA, *Southern District of New York,* } *ss:*

Seal of U. S. Circuit Court, South. Dist. New York.

I, John A. Shields, clerk of the circuit court of the United States of America for the southern district of New York, in the second circuit, do hereby certify that the foregoing pages, numbered from one to 380, inclusive, contain a true and complete transcript of the record and proceedings had in said court in the case of National Meter Company, complainant & appellant, against The Board of Water Commissioners of the City of Yonkers, defendant & appellee, as the same remain of record and on file in said office; and I do further certify that the paper exhibits returned herewith by order of court, to wit, Complainant's Exhibits D E, F G, and H I and Defendant's Exhibit File Wrapper and Contents Nash Reissue, are the originals on file in [illegible] office.

In testimony whereof I have caused the seal of the said cou[illegible] be hereunto affixed, at the city of New York, in the southern [illegible] trict of New York, in the second circuit, this 11th day of O[illegible] in the year of our Lord one thousand eight hundred and [illegible]

nine, and of the Independence of the said United States the one hundred and fourteenth.

JOHN A. SHIELDS, *Clerk.*

382 NAT. METER CO. *vs.* YONKERS.

COMPLAINANT'S EXHIBIT D E, FILE-WRAPPER & & CONTENTS OF NASH ORIGINAL PATENT, OCT. 13, 1888.

(2–175.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the letters patent granted Lewis H. Nash, assignor to "National Meter Company," January 21, 1879, number 211,582, for improvement in water meters.

Seal Patent Office, United States of America.

In testimony whereof I, Benton J. Hall, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 2d day of June, in the year of our Lord one thousand eight hundred and eighty-eight, and of the Independence of the United States the one hundred and twelfth.

BENTON J. HALL,
Commissioner.

383 *Petition.*

$15. H. D'g, mod.

To the Commissioner of Patents:

Your petitioner, a resident of Brooklyn, New York, prays that letters patent may be granted to the "National Meter Company," of New York city, New York, as his assignee, for the invention set forth in the annexed specification, vesting in said company and its legal representatives the exclusive right of the same upon the terms and conditions expressed in the act of Congress in that case made and provided.

And further prays that you will recognize Johnson and Johnson, of Washington, D. C., as — attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and transact business in the Patent Office connected therewith.

LEWIS H. NASH.

I concur in the above.

JOHN C. KELLEY,
P't National Meter Co.

384 *Specification.*

To all whom it may concern:

Be it known that I, Lewis H. Nash, late of South Norwalk, Connecticut, but now of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful improvements in water meters, and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings and to letters of reference marked thereon, which form a part of this specification:

385 In improving water meters my object is to obtain accuracy of measurement with simplicity and durability of construction, effecting a positive displacement of water by means of a rotary piston having certain continually oppositely changing points or lines of bearing or contact with a cylinder having wall recesses and projections, whereby said cylinder is divided by said piston into receiving and discharging spaces, which continually change their volume and in which the piston effects such changes by reason of its own form and compound motion in relation to the cylinder.

Not understood; should be struck out.*

Substitute "D," Oct. 21, '78.

A distinguishing feature of novelty consists of a rotary piston having two motions—one of rotation around its own centre and the other a rotation around the centre of the cylinder—by which to effect the changes in the volume of the divided spaces in the cylinder by the continually changing bearing points or

386 lines of the two parts giving an approximately rolling motion to the piston, in which it will maintain continually a contact at two or more points on opposite sides of the cylinder. The displacement of water in a meter by reciprocating pistons, while effecting accurate measurement, has the disadvantage of interfering with the flow and necessarily the loss of pressure. It is one of the objects of my new rotary piston to overcome this vital objection by having a continuous flow without interfering with the accuracy of the measurement and obtaining the benefit of the full pressure.

The rotary piston operates in its rolling movements with continually changing bearing points upon opposite sides of the cylinder for a specific purpose, and, while these bearing points or lines may be [illegible] different forms, they must of necessity form alternate wall [illegible] jections and recesses adapted for co-operative action with [illegible]

* In pencil in copy.
Words and sentences enclosed between rules erased in copy.

responding parts on the piston, arranged within said cyl-
387 inder, but a requisite of such co-operation is that the pis-
ton must have one or more points or lines of bearing less than those of the cylinder to admit of the compound movement of the piston to effect the division of the cylinder as stated.

The object of these continually changing points or lines of contact and the continually changing volumes of the spaces formed thereby is to allow the water to flow through a valve into and from these spaces as they fill and discharge, while such flow is controlled by a valve formed with and constituting a part of the piston or separate therefrom and controlled by a connection therewith.

In the arrangement of the valve the cylinder spaces on one side of the piston as it revolves have free inlet through one set of the valve ports, while the spaces on the other side of the piston have free outlet through the other ports of the valve, causing the
388 piston to move. In this operation the valve opens some and closes others of the ports in succession in such a manner as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the movement of the piston as it revolves, and thereby avoid any undue lateral pressure upon the piston. This result is accomplished in a more satisfactory manner by increasing the number of the bearing points of the cylinder and piston, as shown in figure 3. When the valve is arranged within the piston it is formed by openings or ports in the ends of the piston, communicating by means of passages in or through the piston with the spaces of the cylinder, said end openings or ports acting with corresponding openings or ports in the ends of the cylinder which form the inlet and outlet ports. When the valve is separated from the piston the latter has no inlet and outlet ports, but these are formed within a case
389 forming part of the cylinder and operate in the same manner with respect to the constantly changing cylinder spaces, while the action of such separate valve is the same as that formed within the piston, and its motion is controlled by any suitable attachment with said piston, so that the results of such arrangements of the valve are identical, for in the movements of the piston in the manner stated any suitable form of valve may be used so long as its movement will have a periodic relation to the movement of the piston to effect the object stated.

An important feature of my invention embraces the combination, with a piston having a compound rotation, of a valve controlled thereby irrespective of its specific construction or arrangement. The cylinder and its piston are enclosed by a case in a manner to leave a space around said cylinder for the inflow and outflow, and renders the pressure uniform upon the working parts.

Words and sentences enclosed between rules erased in copy.

390 Referring to the drawings—

Figure 1 represents a vertical section of a water meter embracing my invention;

Figure 2, a top view, with the case removed, showing one of the cylinder ports;

Figure 3, a similar view, the cylinder head being removed, showing one form of the cylinder bearing lines or points in

J. & J. connection with the rotary A and side-rocking piston co-operating therewith and in which the valve is shown as being within the piston, as in Figs. 1 and 2;

J. & J. Figure 4, the rotary A and side-rocking piston, with its enclosed valve;

Figure 5, a partial side view of the same, showing the end ports communicating with the lateral passages;

J. & J. Figure 6, a perforated device at the A cylinder chamber inlet port adapted to form a close-wearing joint for the piston;

391 Figure 7, a vertical section of a modified form of meter

J. & J. to illustrate the arrangement with the rotary A and side-rocking piston of a valve separated therefrom, but controlled by the motions of said piston;

Figure 8, the arrangement of the inlet and outlet pas-

J. & J. sages into and from the cylinder A chamber and a valve separated from the piston, taken on line *a a* of Fig. 7; Fig. 8*a*, section on line *b b*, and Fig. 8*b*, the A separate valve.

Figures 9, 10, and 11 are modified forms of the cylinder

J. & J. bearing points or lines and the corresponding forms of A side-rocking and rotary pistons adapted for co-operation therewith; and

Figure 12 shows the direction of the line of pressure upon the piston in relation to its continually changing motion and the divided cylinder spaces.

The case I prefer to make in two parts, one, A, of which

J. & J. forms the head or base, has the inlet and outlet passages, which communicate with the cylinder-chamber ports, while the other part, B, forms the enclosing case and carries the dial mechanism.

392 The cylinder C is secured to the base in any suitable way, leaving a space, D, between its walls and the case B, which space communicates with the outlet passage E, while the inlet passage F communicates with the cylinder inlet port by an opening or openings, G, in the base.

The case B may or may not be used, but when it is it serves to form the space D surrounding the cylinder and to relieve the working parts from undue pressure. In Fig. 7 the construction does not require the enclosing case.

The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses *a a'* and projections *b b'*, of such form or configuration

as to allow of the rotation of the piston, not only upon its
across
J. & J. own axis, but around and ʌ the centre of the cylinder, and
the space within the cylinder must be of such form and
393 sufficiently larger than the piston H to allow it to have
this compound motion.

The object of this compound motion is to form bearing points or lines of contact of the piston with the cylinder walls on opposite
as shown in Figs. 3 and 12,
sides thereof at the same time, ʌ whereby to divide the cylinder into receiving and discharging spaces. Of whatever form these alternate recesses and projections, they must be such that while they are in contact upon one side of the cylinder they must also at
or a different
J. & J. the same time have a contact at the opposite ʌ side of said cylinder and in this way divide the cylinder into spaces. In this contact it will be observed that upon one side of the cylinder and piston such contact takes place between a recess and projection or intermediately between these points, while upon the opposite side such contact is made by corresponding projections,
in Figs. 3 and 12.
as shown ʌ Intermediately between these points of bearing
cylinder
394 and division it is advantageous that the ʌ spaces *c* should
by the depressions *c'*,
communicate ʌ whereby to prevent the choaking of the flow and ensure a uniform action of the piston.

The compound motion of the piston and the contacting dividing points are due to the fact that the piston has one or more less points of projection than the cylinder. When the valve is formed within the piston, as shown in Figs. 1, 2, 3, 4, and 5, the heads of the cylinder have inlet and outlet ports J and K, which must have such form as to act in connection with ports in the piston to form a valve. As shown in these figures, the valve is formed within or is a part of the piston, and it consists of ports *d d'*, in the ends of the piston, communicating with lateral passages *e e'*, which communicate with the spaces *c* of the cylinder which form the receiving and discharging divisions. The ports *d'* receive the water from the cyl-
395 inder port J and discharge it into the cylinder spaces *c* through the lateral passages *e'*, while the ports *d* discharge the water from the cylinder spaces through the passages *e*, the water flowing from the valve ports *d* through the cylinder port K, whence it passes into the surrounding space D and out through the discharge pipe at E. With this construction of valve I deem it advisable to use a self-adjusting perforated device, L, as the inlet port, which is carried and held against the piston by the flow of
against its perforated end, causing the opposite end
J. & J. the water ʌ to maintain a close joint with said piston to take up the wear. The function of the valve is to regulate the flow of the water in and out of the spaces of the cylin-
J. & J. der in such manner as to produce the compound rotation
cross-movement
and ʌ of the piston, and this function can be made operative, whether the valve be arranged within the piston, as described,

or separate from and connected with it, as shown in figures
396 7 and 8 of the drawings, it being only necessary that the motion of the valve should be controlled by the compound motion of the piston in any arrangement, and I do not wish to confine myself to either of the specific arrangements of the valve shown or to any specific construction of such valve in relation to the piston so long as the valve and the piston co-operate to produce the results stated.

The valve shown in figures 7 and 8 consists of revolving cylinder M, which by a partition divides the inlet from the outlet and is supported by a fixed stem, *f*, within its seat. The water enters through the top of the valve by the ports *h* and passes out through a side port, *g*, in said valve into corresponding ports *i*, in the valve seat, thence through the passages *j j* into the filling spaces *c* of the cylinder, and from the discharging spaces it passes through the passages *j' j'* and the ports *i'* in the valve seat, through the
397 port *g'*, and escapes through the bottom of the valve into the discharge pipe.

Any of the various forms of the piston shown may be used with the separate valve by making the number of the inlet and outlet ports of the valve seat to correspond to the number of the bearing projections of the cylinder. In the arrangement of the
J. & J. separate valve it is operated Λ [connected]* by a crank or slotted Λ disc, *m*, and Fig. 7, Λ [to]* a pin, *n*, Λ on the piston, or any other suitable con-
J. & J. that will allow of the side movement of the piston. nection may be made Λ The piston is connected to the
J. & J. dial mechanism by a pin, *o*, engaging by a free action Λ with or operating an arm, *p*, of the train of the interior gear, whereby the rotations of the piston are recorded by the usual dial indices.

The recording device is mounted in a separate outside case and connected with an interior train by means of a shaft through a stuffing box, as in ordinary dry-dial attachments.

398 It is required, in order to get the best results, that the valve should open and close its inlet and outlet ports in succession in such a manner as to keep the line of pressure as nearly as possible at right angles to the direction of the motion of the piston. By the line of pressure I mean a line connecting the points of division which separate the inlet from the outlet spaces *c* of the cylinder, as shown by the [dotted]* line *z* in Fig. 12, and by a line of motion I mean a line which is tangent to the path of the axis of the piston at any point of such path as shown by the arrow *y* in said Fig., and in this way these lines continually change
J. & J. their position as the piston rotates and rocks sidewise.

I prefer to make the piston of hard rubber, but it may be made of any suitable material, and either in one piece with the valve or the latter may be made in the form of a plug and
399 inserted within an opening in the piston.

I have described and prefer in practice that the piston shall

* Words enclosed in brackets erased in copy.

have the compound motion described, but it is obvious that the piston may be fixed and the cylinder be made to have the relative compound motion, so, in like manner, both the cylinder and the piston may have a separate conjoint motion, yet retaining the same relation to each other. In the use of the meter the inlet may become the outlet and *vice versa*. It is also contemplated to use the machine as a motor or as a pump, and in the former case the power is taken from the piston through a shaft or otherwise, and in the latter case the power is applied to the piston in the same manner. A

*[Insert "A," Sept. 19, '78.]

Insert "E," Oct. 21, '78.

400 I claim—

1. In a water meter a rotary piston having alternate recesses and projections, in combination with a cylinder having A corresponding recesses and projections, forming points or lines of bearing or contact at two or more opposite points within any part of the revolution of said piston, for the purpose stated.

one or more, greater number of

Substitute "F," Oct. 21, '78.

Clapp, 21550.†

2. A cylinder having interior alternate projections and recesses in combination with a piston having one or more less corresponding projections than the cylinder, to allow of the division of the cylinder into receiving and discharging spaces and of the rotation of the piston around the centre of said cylinder.

*[Substitute "B," Sept. 19, '78.]

Same.†

3. A cylinder and piston having alternate projecting bearings, in combination with a piston having a compound motion within said cylinder, for the purpose stated.

Same.†

Erase per am'd't Oct. 21st, 1878.

3. [4.]* The combination, with a piston adapted by its construction and compound motion to divide the cylinder into receiving and discharging spaces, of a valve, controlled by said piston, adapted to open and close receiving and discharging ports in succession to effect the rotation of the piston.

401

4. [5.]* A rotary piston for a water meter having a valve formed by depressions or passages therein, which act in connection with receiving and discharging ports A in the cylinder to form said valve.

or with passages

*[Substitute "C," Sept. 19, '78.]

6. The self-adjusting perforated inlet port of the cylinder, in combination with the rotary piston, adapted for use as stated.

* Words and figures enclosed in brackets erased in copy.
† In pencil in copy.
Words and sentences enclosed between rules erased in copy.

Erase per am'd't Oct. 21, '78.

6. [7.]* The cylinder C, having end ports and the rotary piston H, arranged therein, in combination with the enclosing case B, forming the space D, surrounding said cylinder and communicating with either the inlet or the outlet port, as stated.

402 In testimony that I claim the foregoing I have affixed my signature in the presence of two witnesses.

LEWIS H. NASH.

Witnesses:
A. E. H. JOHNSON.
J. W. HAMILTON JOHNSON.

403 *Oath.*

DISTRICT OF COLUMBIA, *City and County of Washington,* } ss:

On this twenty-first day of August, 1878, before me, the subscriber, a notary public, personally appeared the within-named Lewis H. Nash and made solemn oath that he verily believes himself to be the original and first inventor of the improvements in water meters herein described, and that he does not know or believe the same was ever before known or used, and that he is a citizen of the United States.

J. W. HAMILTON JOHNSON,
[L. S.] *Notary Public.*

Comp'd:
J. B. BANKS.
A. C. WICKWARE.

[Endorsed:] In the U. S. Patent Office. In the matter of the application of —— —— for letters patent for —. Petition, oath, specification, and power of attorney. (U. S. Patent Office, Sep. 4, 1878.)

404 Copied.

Room No. 118.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sept. 18th*, 1878.

Lewis H. Nash, care Johnson & Johnson, present.

Water meter. Filed Sept. 4, 1878.

Upon examination of this application the 2d & 3d claims are found to be substantially anticipated in the patent of M. R. Clapp,

* Words and figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

No. 21550, Sept. 21, '58 (rotary pumps). The subject-matter of the 6th claim covers nothing more than is shown in any meter that has a strainer such as seen in patent of I. Cook, June 4, '72, No. 127,575 (meas. inst's, rotary meters).

The 2d, 3d, & 6th claims are rejected.

W. S. CHASE, *A. A. Ex'r.*

H. C. TOWNSEND, *Ex'r.*

[Endorsed:] $\frac{4\,0}{1\,0}$. 1. Rejection. September 18, '78.

405 WASHINGTON, *Sept. 19th*, 1878.

The Commissioner of Patents.

SIR: In the matter of the application of Lewis H. Nash for a patent for water meter, filed Sept. 4th, 1878, we hereby amend the same as follows, viz:

Insert at the end of the description and before the claim the following, viz:

["A."]* Cancel per am'd't Oct. 21, 1878.

"The self-adjusting inlet port device L, shown in Figs. 1 and 6, is adjustably seated within and forms said port and has side walls, one end perforated and its other end open and provided with a rim, which bears upon the receiving end of the piston, for the purpose stated."

Erase claims 2 and 3 and insert the following, viz:

["B."]* Cancel per am'd't Oct. 21, '78. J. & J.

J. & J.

"2. The piston H, having a revolving motion upon its own axis and an eccentric revolution within the chamber of the cylinder, both said movements being effected by the A [force of the water alone]* A said piston and cylinder having alternate recesses and bearings [whereby to],* forming points or lines of bearing or contact at two or more opposite points within any part of the revolution of said piston, to effect the division of said cylinder into separate and distinct receiving and discharging spaces *c* on each side of and by the movements of said piston, substantially as and for the purpose described."

406

relative shape of the cylinder and piston and the action of the water upon the latter,

* Words and figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

Erase claim 6 and insert the following, viz:

["C."]* Cancel per am'd't Oct. 21, '78.	5. [6.]* "The inlet device L, having side walls, a perforated end, and an open end, bearing rim, seated adjustably in and forming the inlet port J, in combination with the rotary piston, against one end of which it bears, for the purpose stated."

Change the ordinals in accordance herewith.

A reconsideration of the claim as amended is respectfully requested.

The construction and mode of operation of the applicant's device is entirely different from that of Clapp's pump, which, it will be seen, has a semi-cylinder revolving concentric with the enclosing cylinder and carrying within its concave side a piston also revolving concentric with the enclosing cylinder, and both the segment cylinder and the piston revolve upon axis stems.

407 This is utterly different from the applicant's piston in operation, as both its movements within the cylinder are affected by the direct force of the water acting to revolve the piston and to carry it eccentrically.

Very respectfully, your ob't servants,

JOHNSON AND JOHNSON,
Att'ys for Lewis H. Nash.

[Endorsed:] $\frac{4}{10}$. 2. Amendment. Sept. 19th, 1878. "A, C." Mr. Examiner Townsend. Amendment. L. H. Nash. U. S. Patent Office, Sep. 19, 1878.

408 Copied.

Room No. 118.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sept.* 24, 1878.

Lewis H. Nash, care Johnson & Johnson, present.

Water meter. Filed Sept. 4th, 1878.

In view of amendment filed Sept. 19, '78, this case has been again considered.

The 2d claim appears vague, in that it does not distinguish sufficiently between applicant's device and the reference previously cited.

* Words and figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

As presented the 2d claim is rejected.

W. S. CHASE, *A. A. Ex'r.*

H. C. TOWNSEND, *Ex'r.*

[Endorsed:] $\frac{40}{10}$. 3. Rejection. Sept. 24, 1878.

409 WASHINGTON, *Oct. 16th*, 1878.

The Commissioner of Patents.

SIR: In the matter of the application of Lewis H. Nash for a patent for water meter, filed Sept. 4th, 1878, we hereby amend the same as follows, viz:

Erase pages 1, 2, 3, 4, and 5, inclusive, and insert the following, viz:

"To obtain accuracy of measurement in a water meter with a construction specially adapted for durability of operation, and by which a positive displacement of the
"D." water is effected without impeding the flow and interrupting the pressure of the head, is the object of my invention.

"Water meters adapted with reciprocating pistons, while effecting accurate measurement, have the disadvantage of interfering with the flow, and as a consequence entails the loss of pressure in the flow.

"In my improved meter I use a piston adapted to have an
410 eccentric or side-rocking motion across the centre of a cylinder chamber to effect its division at two or more points into receiving and discharging spaces. The piston operates with two or more continually changing points or lines of bearing or contact with two or more points or contact bearings of the cylinder at different points at the same time, by which the receiving and discharging spaces of the cylinder are caused to continually change their volume with an unobstructed flow and a positive displacement of the water from the discharging space of the cylinder by the rocking of the piston from one bearing point to another across the chamber of the cylinder. With this eccentric or side-rocking action the piston also revolves around its own centre, and both these movements are effected by the relative shape of the piston and cylinder and by the direct action of the water upon the piston, for as the piston rocks from one bearing point to another directly across the centre of the cylinder it is at the same time revolved to effect the measurement of the water passing
411 into and from the cylinder spaces, and to accommodate this eccentric or side-rocking motion of the piston it must have a free or shifting connection with the crank or mover of the registering mechanism. The continually changing points or lines of bearing of the piston and cylinder are formed by alternate projections and recesses, and the eccentric or side-rocking movement of the piston is governed by the extent of the projecting bearing points and the depth of the recesses,

so that in the rotation of the piston around its own centre one or more projecting bearing points of the piston will pass into corresponding recesses at one point of the cylinder and in contact with and over one or more projecting bearing points of the cylinder at a different point, thereby always maintaining a direct contact of the piston and cylinder at two or more dividing points within the continually changing cylinder spaces and obtain- thereby a continuous flow without interfering with the pressure of the head. The object of these continually changing points or lines of contact at dif-
412 ferent parts of the piston and the cylinder and of the continually changing volumes of the receiving and discharging spaces formed thereby is to allow the water to flow through a valve into and from these spaces as they fill and discharge without impeding its flow or lessening its force. In this connection and for effecting this operation the valve may be formed with and constitute a part of the piston or it may be separate therefrom and controlled by a connection therewith. The valve is arranged so that the cylinder spaces on one side of the piston as it revolves have free inlet for the water through one set of the valve ports, while the spaces on the other side of the piston have free outlets for the water through the other ports of the valve, causing the piston to move with the flow. In this operation the valve opens some and closes others of the ports in succession in such a manner as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the eccentric or side-rocking and rotary
413 movements of the piston, and thereby avoid any undue lateral pressure of the water upon the piston. This result is accomplished in a more satisfactory manner by increasing the number of the bearing points or lines of the cylinder and piston, as shown in Fig. 3. When the valve is arranged within the piston it is formed by inlet and outlet openings or ports in the ends of the piston communicating by means of passages in or through the piston with the spaces of the cylinder. These end openings or ports communicate with corresponding openings or ports in the ends of the cylinder which form the inlet and outlet ports thereof. In the arrangement of the valve separate from the piston the latter has no inlet and outlet ports, but these are formed within a case communicating with the cylinder and operate in the same manner with respect to the constantly changing cylinder spaces, and the action of such separate valve is the same as one formed within the piston and its motion is controlled by any suitable free attachment with said piston. The
414 results of these different arrangements of valves are identical, and any suitable form of valve may be used that will operate with a periodic relation to the movements of the piston so as to give a uniform flow and a uniform pressure upon the working parts."

1/ Cancel the amendment filed in the case.

Insert at the end of the description and before the claim the following, viz:

"The self-adjusting port device L, shown in Figs. 1 and 6, is adjustably seated within and forms said port and has side walls, with one end perforated and its other end open and provided with a rim, which bears upon the end of the piston, to effect the object stated.

"An important feature of my invention embraces the com- "E." bination, with a piston adapted to operate substantially as described, of a valve controlled thereby irrespective of its specific construction or arrangement.

"When an enclosing case is used in connection with the so
415 cylinder they are A arranged in relation to each other as to form an intermediate surrounding space, communicating with the end ports of the cylinder chamber and with the outlet port of the receiving end of the piston, for the purpose stated.

"It will be seen that the connection of the piston with the registering mechanism is such as to allow of a free or shifting action to accommodate the side-rocking movements of the piston across the centre of the cylinder chamber and maintain a driving relation with the dial mechanism."

Erase all the claims presented and insert the following, viz:

1. "A piston for water meters, pumps, and motors, having alternate bearing points or projections and recesses, adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber, to effect its division
416 at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet."

2. "The piston of a water meter, pump, or motor constructed with alternate recesses and bearing points or projections *a* and *b* and a cylinder chamber having alternate wall recesses and bearing points or projections *a'* and *b'*, adapted to intermatch with each other at one or more bearing points at one side of the cylinder and allow the projections of each part to bear "F." upon and to pass each other at two or more points at a different side of the chamber, to allow the piston to revolve while it also rocks in constantly changing lines across the centre of the cylinder chamber, for the purpose stated."

3. "The piston of a water meter, adapted to have an eccentric or side-rocking movement across the centre of the cylinder chamber and a revolving motion, combined with a registering mechanism by means of a free or shifting connection acting with the continually changing side-rocking movements of the piston while maintaining a driving relation with the dial mechanism."

417 4. "The combination, with a piston having an eccentric or side-rocking motion across the centre of the cylinder chamber and a revolving motion around its own centre, to divide the cylinder at two or more bearing points on its sides, of a valve controlled by the movements of said piston and adapted to open and to close receiving and discharging ports in succession, to effect the purpose stated."

Turner.* Substitute "H," Nov. 7, '78. Old.*	5. "A rotary piston having a valve formed by depressions or passages therein and adapted to act in connection with receiving and discharging ports or with passages in the cylinder chamber to form said valve."

7. [6.]† "The inlet device L, having side walls, a perforated end, and an open end, bearing rim, seated adjustably in and forming the inlet port J of the cylinder chamber, in combination with the rotary piston, against one end of which the said device bears, for the purpose stated."

Erase per am'd't Nov. 7, '78. 418 Old. Boyle.*	7. "The cylinder C and the enclosing case B, arranged in relation to each other to form an intermediate surrounding space, D, communicating with the end ports of the cylinder chamber and with the outlet port of the case, for the purpose stated."

Insert "G," Oct. 24, '78.

A reconsideration of the claim is respectfully requested.

As amended, it is believed the claim specifically embraces the applicant's invention. The features therein embraced are wholly beyond the scope of Clapp's patent.

Very respectfully, your ob't servants,

JOHNSON AND JOHNSON,
Att'ys for Lewis H. Nash.

[Endorsed:] $\frac{4}{10}$. 4. Amendment. October 21st, 1878. "D, F." U. S. Patent Office, Oct. 21, 1878.

419 WASHINGTON, D. C., *October 24th*, 1878.

The Commissioner of Patents.

SIR: In the matter of the application of Lewis H. Nash for a patent for water meter, filed Sept. 4th, 1878—

We hereby amend said case as follows:

Insert the following additional clause of claim:

* In pencil in copy.
† Words and figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

"8. The spaces or recesses c', in the walls of the cylinder between the bearing points b' and the recesses a', in combination with the piston, having alternate bearing points and
"G." recesses whereby to prevent the choking of the flow and ensure an uniform action, of a piston adapted for operation with a side-rocking motion across the centre of the cylinder and a rotary motion around its own centre."

Very respectfully, JOHNSON AND JOHNSON,
Att'ys for Lewis H. Nash.

[Endorsed:] $\frac{40}{10}$. 5. Amendment. October 24, 1878. "G." Mr. Examiner Townsend. Lewis H. Nash. Water meter. Am'd't. U. S. Patent Office, Oct. 24, 1878.

420 Copied.

Room No. 118.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Oct.* 30, 1878.

Lewis H. Nash, care Johnson & Johnson, present.

Water meters. Filed Sept. 4, 1878.

In view of amendments filed Oct. 21 & 24, '78, this case has been again examined. The 5th claim is substantially met in the patent of C. Turner, Mar. 31, '68, No. 76274 (meas. inst's, rotary meters). The 7th claim is anticipated in patent of J. E. Boyle, Mar. 3, '74, No. 148,026 (same class). The 5th & 7th claims are rejected.

W. S. CHASE, *A. A. Ex'r.*

H. C. TOWNSEND, *Ex'r.*

[Endorsed:] $\frac{40}{10}$. 6. Rejection. Oct. 30, 1878.

421 WASHINGTON, *Nov. 7th*, 1878.

The honorable the Commissioner of Patents.

SIR: We have the honor to acknowledge the receipt of the examiner's communication of the 30th ult. in the matter of the application of Lewis H. Nash for a patent for water meter, filed Sept. 4th, 1878.

We hereby amend the same as follows, viz:

Erase claims 5 and insert the following, viz:

5. "A rotary piston having a valve formed therein by opposite end ports or depressions and adapted to act in connection with receiving and discharging ports or passages in
"H." the cylinder chamber to form a valve and piston, into and through which the water entering at the inlet cylinder end ports passes through one end of the valve into the cylinder on one side thereof and, re-entering the valve from the other

side of said cylinder, passes out at the opposite end ports of said valve to effect the purpose stated."

422 6. "A rotary valve piston having opposite end ports *d d'*, communicating with the piston sides by diagonal passages *e e'*, in combination with a cylinder having receiving and discharging ports communicating with said opposite valve end ports and with the receiving and discharging spaces of said cylinder, whereby said valve opens some and closes others of its ports in succession, and to effect the equalization of the pressure of the water at right angles to the direction of the side-rocking and rotary movements of the said valve piston, as stated."

Erase claim 7 and change the ordinal 6 to 7.

A reconsideration of the claim as amended is respectfully requested.

Very respectfully your ob't servants,

JOHNSON AND JOHNSON,
Att'ys for L. H. Nash.

[Endorsed:] $\frac{4}{10}$. 7. Amendment. Nov. 7th, 1878. "H." Mr. Examiner Townsend. Amendment. L. H. Nash. U. S. Patent Office, Nov. 7, 1878.

423 *Memorandum of Fee Paid at U. S. Patent Office.*

$20. H.
Inventor:
Louis H. Nash.
Patent to be issued to:
National Meter Co.
Name of invention as allowed:
Rotary water meters.
Case A.
Date of payment:
Jan'y 3d, 1879.
Fee:
Final, $20.
Solicitor-:
Johnson and Johnson.
Date of circular of allowance:
Nov. 14th, 1878.
Send patent to:
National Meter Co., 95 John St., New York city.

[Endorsed:] (U. S. Patent Office, Jan. 3, 1879.)

1878.

Div. 16. $\frac{40}{10}$.
Townsend.
Case A.
See slip.

No. 211,582.

Reissued Feb'y 8, 1887. No. 10806.

Lewis H. Nash, ass'or
To "National Meter Company" of New York, N. Y.,
Of Brooklyn,
County of Kings,
State of New York.
Water meters.

Rec'd Sept. 4, 1878.
Petition, " " "
Affidavit, " " "
Specification, " " "
Drawing, 5 sheets, " " "
Model, " " "
Cert. dep., —.
1. Cash, $15, Sept. 4, 1878.
Add'l fee cert., —.
1. " " cash, $20, Jan'y 3, 1879.
Examined Nov. 13, 1878. H. C. Townsend.
2. Issue, Nov. 14, '78. F. A. Seely.
4. Patented Jan. 21, 1879.
Circular, Nov. 14, 1878.
Johnson & Johnson, present.

424 1878.

Contents.

Application papers.
1. Rej'd Sept. 18, 1878.
2. Am'd't, Sept. 19th, '78, "A C."
3. Rej'd Sept. 24, 1878.
4. Am'd't Oct. 21, '78, "D F."
5. " " 24, " "G."
6. Rej'd Oct. 30, 1878.
7. Am'd't, Nov. 7th, '78, "H."
8. Brief, Nov. 13, 1878.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.

Rotary meters.

Title: 1/
Improvement in rotary water meters.
8.
78. Measuring instruments.
Rotary meters.

E. L. Layne.
M. F. Moore.

[Endorsed:] 10751. D. '88.

425 NAT. METER CO. vs. YONKERS.

COMPLAINANT'S EXHIBIT F G, FILE-WRAPPER & CONTENTS TILDEN PATENT OF AUG. 18, 1885. Oct. 13, 1888.

(2-175:)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the letters patent granted James A. Tilden, assignor to Hersey Brothers, August 18, 1885, number 324,503, for improvement in rotary fluid meter.

In testimony whereof I, Benton J. Hall, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 2d day of June, in the year of our Lord one thousand eight hundred and eighty-eight, and of the Independence of the United States the one hundred and twelfth.

Seal Patent Office, United States of America.

BENTON J. HALL,
Commissioner.

426 $15, ch'k.

Thos. Wm. Clarke. F. F. Raymond, 2d.

29 PEMBERTON SQUARE, BOSTON, *Dec.* 20, 1884.

Commissioner of Patents, Washington, D. C.

SIR: We beg to enclose the application for patent of James A. Tilden, of Hyde Park, Mass., for improvement in fluid meter, and check for $15.00 in payment of fee.

Very respectfully, CLARKE & RAYMOND.

[Endorsed:] United States Patent Office, Dec. 22, 1884.

427 *Application for Letters Patent.*

To the Commissioner of Patents, Washington, D. C.

Your petitioner, of Hyde Park, in the county of Norfolk and State of Massachusetts, hereby prays that letters patent may be granted him for improvement in fluid meters, set forth in the annexed specification, and hereby appoints Thos. Wm. Clarke and F. F. Raymond, 2d, of 29 Pemberton square, Boston, Mass., his attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith.

JAMES A. TILDEN.

428 *Specification.*

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawing, forming a part of this specification, in explaining its nature.

It is well known that a fluid meter to be commercially successful must be capable of perfectly measuring or indicating the quantity of fluid which passes through it, regardless of the size of the stream, its speed, head, or any other condition; that it must not easily get out of repair; that its construction must be simple and its manufacture inexpensive, and various meters have been made with some, if not all, of these conditions; but, so far as I am aware, there is not at present in the market any meter which combines all of these features, with certain necessary wearing qualities, to such an extent that it may be said to be a really commercially successful or practical meter, and while my invention may not be perfect in every respect, yet it has all the requisites of an efficient, desirable, and cheap meter.

The principle upon which the meter is constructed is so simple that but very few parts or pieces are necessary and very little
429 machine work required in fitting them, and these can be placed in such very small compass that the weight of metal necessary for the casing is very small.

The invention comprises, broadly speaking, a chamber having exhaust inlet and exhaust ports and a piston for opening and closing the A ports. The meter can hardly be called a rotary meter, because the piston does not rotate, and yet it is quite unlike in appearance any of the ordinary reciprocating-piston meters, but it combines, it may be said, portions of both systems in substantially this manner.

measuring The A chamber of the meter is divided or separated upon its outer

measuring
edge into A spaces or recesses, all of which open into the central portion of the chamber, but which A may or may not be of uniform size and shape. Each of these spaces has its individual inlet and exhaust ports. The part which I call the piston has a radially extending portion or lobe, which enters each measuring space or recess and does not at any time leave it, and has a movement therein that causes it to be brought into contact with one side of each recess near the mouth A and to advance along the side continuously until it reaches the other side of the recess, when it returns across the mouth of the recess or space to its original position. This movement of each lobe in each space or recess alternately exposes and closes the exhaust ports, thereby preventing the flow of liquid from the chamber only after it has entered what may be termed the measuring and A discharging spaces or recesses.

The sides of the chamber and the sides of the piston should be parallel when the piston is centrally located in the chamber.

To understand the working of the device it must be borne in mind that the liquid has free access to the chamber—that is, its
430 inlet ports are never entirely closed; that because of the shape of the wall of the chamber and of the piston the piston is kept in contact with the wall of the chamber at a number of what I call contact points or lines, which form in the measuring and discharging passages spaces or recesses. The number of the lines of contact depend, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary because a full head is maintained in the larger part of the chamber, and it is, of course, necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by liquid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes, in connection with the portions of the wall which constitute or form the spaces or recesses, also act to separate the exhaust ports from the inlet ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact lines, one between the outer surface of the lobe and the wall of the recess and the other between the surface of the inward projection of the wall and the surface of the piston between the lobes. These lines of contact continually advance until the water has been expelled from each space or recess. While, however, this discharge from each space or recess is going on by the movement of the lobe the space or recess is filling behind the lobe.

Of course, the number of spaces or recesses which are discharging simultaneously depend upon the entire number of spaces or recesses which the chamber contains, and there may be several recesses or spaces discharging and receiving at the same time. This
431 advancing movement of the lobe in each space or recess does not continue beyond its individual space, but upon reaching the end of that space or recess it returns across the mouth or entrance of its recess or space to its original position, while the piston, as a whole, without revolving, moves on a circular path.

In the drawings—

Fig. 1 represents a side elevation of the machine.

Fig. 2 is a plan view of a portion of the meter above the line $x\ x$ of Fig. 1, inverted, showing the piston and upper series of exhaust ports.

Fig. 3 is a view, principally in vertical central section, showing especially the mechanism for connecting the piston with the registering train.

Fig. 4 is a section upon the line $y\ y$ of Fig. 3, also showing the lower series of exhaust ports and the inlet ports.

Fig. 5 is a view, principally in vertical section, upon the line $z\ z$ of Fig. 4, showing especially the relation of the exhaust ports, meter walls, and spaces or recesses A when discharging.

Fig. 6 is a plan view of the packing piece between the base and main sections of the meter.

Fig. 7 is a plan view of the base section, showing the receiving chamber and the inlet and outlet passages.

Fig. 8 is a perspective view of the piston.

Figs. 9 to 15, inclusive, illustrate special details of a modified form of construction.

Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction.

Fig. 19 is a diagram showing by calculation the differences in pressure which cause the action of the meter.

Figs. 20 & 21 are sections of the reducing gears hereinafter described; and

Fig. 22 is a view of the sleeve forming the support of the A drum carrying the gears.

Preferably the casing of the meter comprises three principal parts or sections: first, the base section A; second, the body or main section B, and, third, the shell C, forming the chamber c containing the registering mechanism.

The base section is made somewhat larger in circumference than the main section, and the two parts are fastened together by bolts a, which pass through the flange b of the main section. The base section has the inlet passage a', which opens into the distributing chamber a^2 and the outlet passage a^3. The distributing chamber a^2 occupies almost the entire upper portion of the base, and its object is to provide means for the ready distribution of fluid simultaneously through the various inlet ports to the main chamber D.

Between the sections A B is a packing ring, B′, which is shaped as shown in Fig. 6 and is provided with holes for the bolt holes, the inlet ports, and outlet passage. Above this packing ring is a metal plate, B^2, which may be called a port plate.

It rests upon the packing ring B′ and is held or fastened in place upon it and the upper surface of section A, surrounding the chamber a^2 and the central projection a^4, by the bolts a, the plate being within the main section B and its edge projecting into a recess formed in the under edge thereof. This port plate has the holes E

which form the inlet ports to the chamber D and connect the distributing chamber a^2 therewith. These ports E are arranged preferably to open into each space or recess d of the chamber D at one side thereof. The port plate also has a central hole which forms a portion of the outlet a^3 and the escape or exhaust ports E′, which are recesses formed in the upper surface of the plate and arranged to extend from one side of each recess or space d inward measuring
433 upon converging lines. The chamber D has the A recesses or spaces d arranged about its outer edge, which open into the central portion, and the projections or portions of the wall of the chamber which form spaces or recesses I have lettered d'. The piston F preferably is made of hard, vulcanized India rubber, gutta-percha, or other equivalent material and has the wings or lobes f, which extend radially therefrom and the central hole f'.

but not essential
For the best working of the device it is desirable A that the surface of the piston, when the same is centrally located in the chamber D, shall be parallel with the surface of the chamber, so that as the surface of the chamber is made up of alternating recesses and projections, so the surface of the pistons is made up of alternating lobes and recesses.

The central hole f' of the piston forms a part of the exhaust or outlet passage and is large enough to always permit the escape of fluid therefrom into the outlet a^3, regardless of the position of the piston.

In addition to the lower set of exhaust ports, E′, I have formed in the under surface of the upper plate, b^2, which forms the top of the main section B, another set of exhaust ports, E^2, shown in Fig. 2. They are of the same shape and connect the same parts of the spaces or recesses with the opening f' as the lower exhaust ports, E′. There is also arranged in the hole f' a perforated disc, G (see Fig. 2 and 3), by which motion is communicated to the shaft which operates the train of gears comprising the registering mechanism. This disc carries at its center a stud, g, which projects downward from the drum g', which is pivoted at g^2 to the screw-sleeve g^3, which passes through the hole in the plate b^2 and is locked thereto by the nut g^4, which screws upon the thread g^5, and the movement of the piston causes the drum to be revolved upon the sleeve—that is, the
434 drum and stud form substantially a crank.

It is necessary, however, as the chamber is of small capacity and as the motion of the piston is rapid, to reduce the motion of the piston very considerably, and it is desirable to do so in as simple a manner and with as few parts as possible, in order that the construction may be cheap and as little weight of metal used as possible; and I employ for this purpose a train of four gears, one of which, g^6, is stationary, being [radially]* secured to the end of the sleeve g^3. The gears g^7 g^8 are attached to the drum by the shaft or pinion g^9, to which they are keyed, and the gear g^7 meshes with the gear g^6.

* Words and figures enclosed in brackets erased in copy.

The gear g^8 is arranged to mesh with the fourth gear, g^9, which is keyed or fastened to the spindle g^{10}, which communicates motion to the registering train. As the drum revolves about the sleeve g^2, it is obvious that if the gear g^7 has more or less teeth than the gear g^6 it will be caused to move each revolution of the drum a certain portion of a revolution, depending upon the difference in the number of teeth between the two gears. It is also obvious that if the gears g^8 g^9 have the same number of teeth as the gear g^7 that a movement of rotation will be communicated to the shafts or spindle g^{10}. If it is de[riv]*sir ed to still further reduce or change the rate of the rotation of the shaft g^{10}, then the gear g^8 may have more or less teeth than the gear g^7, as the case may be, as also may the gear g^9; and in the drawings I have represented the gear g^6 as provided with 10 teeth, the gear g^7 with 9 teeth, the gear g^8 with 8 teeth, the gear g^9 with 9 teeth, so that upon every complete revolution of the drum the shaft g^{10} is moved $\frac{1}{80}$ of a revolution[s]*, and it therefore requires 80 revolutions of the drum to make one complete revolution of the shaft, the spindle or shaft g^{10} being used, of course, to operate any registering mechanism.

Not evident.†

June 6, '85.

Insert E, June 6, '85.

435 In operation the liquid passes into the distribution chamber a^2 and through the inlet ports E into the chamber D, moving the piston towards one side of the chamber and causing the formation of measuring or discharge spaces by the contact of the various portions of the piston with the chamber wall. This position of the piston is well shown in Fig. 4, where there have been formed six divisions of the three spaces or recesses d by the contacting of the piston at the points 1, 2, 3, 4, 5, 6, and 7, and of these three recesses or spaces two, namely, the small spaces marked M and the space M′, are connected by the discharge ports E′ E^2 with the escape passage, while the space M^2 is about to be; but the fluid, upon being admitted to the chamber under pressure, not only immediately moves the piston to the position shown in Fig. 4, which is one of any number of positions which it might cause it to assume, and from such position it causes it to advance or move so that the lobes which are in contact with the wall of the chamber are caused to continue that contact until they have expelled all the fluid which is in the discharge spaces or recesses before them, when each lobe in succession will leave the surface and return upon an arc of a circle to a position where it again comes in contact with the surface of the wall of the chamber on the opposite side from that which it left, and again advances and expels the fluid from its recess or space.

It will be seen that each recess or space becomes in succession a discharge space or recess, and that as soon as the piston has moved

*Words and figures enclosed in brackets erased in copy.
† In pencil in copy.

sufficiently to uncover the inner end of its escape ports that it begins to discharge through such ports into the escape passages b^3 a^3, and that while a portion of each space or recess is discharging another portion is also receiving the liquid under pressure through the ports E.

436 To illustrate why, with the arrangement of the inlet and exhaust ports described, the piston is compelled to make the motion that it does, I have shown in Fig. 19 by diagrams the difference in pressure upon both sides of the piston and the extent of the surface which is subjected to the direct pressure of the entering fluid.

It is obvious that the chamber D, excepting the spaces which are discharging, is filled with fluid under pressure, and that the pressure for moving the pistons is that which enters each space or recess which is being discharged and behind the respective discharging lobe. For instance, referring to Fig. 4, the piston is receiving motion from the fluid which enters the spaces through the ports marked N N N, but from no other. It is not necessary that the main chamber and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses from three upwards, and that they may be of any size and of different sizes for the same piston, the only difference to be observed being that the piston and chamber wall must be so shaped as to provide the contact lines in the surface of the piston or chamber wall whereby the formation of measuring chambers is effected.

In Fig. 16 I have illustrated a piston having three lobes in a chamber having three measuring and discharge spaces or recesses. In Fig. 17 I have shown a piston with two large lobes and two small ones and a chamber with corresponding recesses or spaces. In Fig. 18 I have represented a piston as having square lobes and the chamber with spaces which substantially follow the shape of the lobes, the only variation being that they are rounded at the corners.

437 It will be obvious from what I have stated that the meter is very simple in construction; that it has but very few parts, which require but little machine work and are easily fitted and put together, and it is also apparent that a substantially perfect registration of the liquid which passes through the meter is obtained, as it all is obliged to pass into the measuring spaces which are successively emptied. It will be seen further that this measuring of the liquid takes place very rapidly and with comparatively very little friction of the wearing parts, and that the construction of the piston and chamber is such that a sediment cannot interfere with the proper working of the invention, and that wear up to a certain extent improves the efficiency of the meter, in that it causes the contacting surfaces of the piston and chamber to fit themselves as they wear.

To still further cheapen the manufacture I show in Figs. 9 to 15, inclusive, a construction which enables me to use instead of the comparatively expensive casing of composition an iron casing. This I accomplish by making the base section entirely of iron, employing two composition plates port A O O′, the plate O being like that de-

scribed and the plate O′ having simply the exhaust passages E^2. The piston is made of hard rubber, gutta-percha, or other like non-
O^2 (see Fig. 14)
corrosive material, and the wall A of the chamber D is formed of a ring or sleeve of gutta-percha, hard India rubber, or even of composition, which is fitted into the iron shell or casing of the main section. This non-corrosive, movable wall of the chamber is fastened to the casing by means of a key, *o*, which enters a groove in the ring and a corresponding one in the inner surface of the iron shell or in any other suitable way. A view in perspective of the movable wall is shown in Fig. 14.

438 It will be seen that by this construction not only can an iron shell be employed, but that the principal wearing parts, namely, the port plates, the piston, and the wall of the chamber, may be easily removed and others substituted therefor. The port plates are also held in place by suitable keys or in any other desirable way, and it will be observed that they extend upon the two end surfaces of the removable wall. (*F*ee Fig. 9.)

Of course, the invention can be utilized as a pump or motor if desired.

Canceled June 6, '85. See cl. 11 & 13.*	I reserve the right to make a separate application as a mechanical movement upon the mechanism connecting the piston with the register.

It will be observed that by making the mechanism for reducing the movement of the piston in compact form I am enabled to place it in the measuring chamber and within the hole formed in the piston, thereby economizing space.

As the gears are enclosed in a drum or casing, no sediment can reach them to disturb their easy action.

While the invention as shown in the drawings represent- a piston which while not rotating moves in a circular path, yet by [follow-
changing
ing]† A the forms of the piston lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, el-iptical, or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston the principle of its action is not

439 changed, as the lobe or portion of the piston which penetrates the measuring space will have a continuous movement in

* In pencil in copy.
† Words and figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

said space, whether its path be circular, square, rectangular, el-iptical, or of any other shape.

Insert A, Apr. 18, '85.
Insert D, June 6, '85.

440 Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. In water meters, pumps, and motors, a chamber having spaces or recesses, each of which has an inlet and exhaust port, with a piston having lobes or projections which enter said recesses or spaces and are caused to have a continuous movement therein.

Substitute B, Apr. 18, '85.
Nash, 211,582, 211,769.*

2. In a water meter, pump, or motor, the chamber having recesses or spaces opening therefrom and a piston having lobes or projections which enter said spaces and which by a continuous movement of each lobe or projection in its own path divides the chamber by successive contact with its walls into discharging and receiving spaces.

Do.*

3. In a water meter, pump, or motor, the chamber having spaces or recesses forming a part thereof, the inlet ports, the exhaust ports, and a piston having the lobes or extensions which describe a separate path and control a separate exhaust passage.

Do.*

4. In a water meter, motor, or pump, a chamber having recesses or spaces, each of which has one or more exhaust ports, and a piston having lobes or projections for controlling said exhaust ports, and a passage connecting said ports successively with the outlet.

Do.*

5. In a water meter, motor, or pump, a chamber having spaces or recesses forming a part thereof, a piston, F, having projections or lobes which describe continuously in said spaces or recesses a continuous movement, with a register and a connecting device actuated by the motion of the piston, all substantially as and for the purpose described.

Do.*

441 6. In a water meter, motor, or pump, a distributing chamber connected with the measuring chamber, uncontrolled inlet ports, the measuring chamber having recesses or spaces, and a piston having projections or lobes which enter the spaces or recesses and have continuous motion therein.

Do.*

7. In a water meter, motor, or pump, the combination of the inlet a^6, distributing chamber, a^2, measuring chamber D, having recesses or spaces d, inlet ports E, piston F, and escape ports and outlet a^3.

Do.*

* In pencil in copy.
Words and sentences enclosed between rules erased in copy.

8. The meter, motor, or pump having the base section A, containing the inlet and outlet passages, and the distributing chamber a^2, the section B, containing the measuring chamber D, and piston F, fastened together by bolts.

Nash, 211,582.*

[9]† 8. The combination of the section A, having the distributing chamber a^2, the section B, and the removable port plate B

Apr. 18, '85.

having the ports E.

[10]† 9. In a meter, motor, or pump, the combination of the section A, having the distributing chamber a^2, the section B, containing the measuring chamber, the port plate B^2, and the packing ring B'.

[11]† 10. In a water meter, as a means for communicating the motion of the piston to the register, the mechanism described, consisting of the stationary gear g^6, the revolving gears g^7 g^8, adapted to be revolved around the stationary gear by the piston, and the gear g^9 upon the connecting spindle.

See on p. 11.*

Cancelled Apr. 18, '85.
Johnson, 264,702.*

12. The combination, in a water meter, of the measuring chamber, the piston, and a device for reducing the motion of the piston contained within the measuring chamber.

[12, 13]† 11. The combination of the piston F, the disc G, the drum or frame g^2, pivoted as described, to be revolved, and the differential gears enclosed within said drum or case.

442

Substitute G, June 6, '85.
Nothing in cl.*

13. [14]† In a meter, motor, or pump, the combination of the metal casing with the removable wall of the measuring chamber.

Nothing in cl.*

metal

14. [15]† The combination of the A casing with the removable port plates.

Do.*

metal

15. [16]† The combination of the A casing, the removable wall A and a locking device for securing the wall to the casing.

of the distributing chamber,

13.*

16. [17]† A water meter, motor, or pump having an iron base section, A,

and

Mere function.*

an iron

† In pencil in copy.
† Figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

	shell, B, having the removable non-corrosive linings, all substantially as and for the purposes described.
Johnson.*	17. [18] In a water meter, motor, or pump, differential gearing arranged between the piston and registering train and in combination with both, all substantially as and for the purposes described.

Insert C, Apr. 18, '85.

JAMES A. TILDEN.

Witnesses:

F. F. RAYMOND, 2D.
FRED. B. DOLAN.

443 STATE OF MASSACHUSETTS, }
County of Suffolk. }

James A. Tilden, the above-named petitioner, being duly sworn, depose- and say- that he verily believes himself to be the original and first inventor of the improvement in fluid meters described and claimed in the foregoing specification; that the same has not been patented in any foreign country by him or to any one with his knowledge and consent.

That he does not know and does not believe said invention has been in public use or on sale in this country for more than two years prior to the filing of his application, and that he does not know and does not believe that the subject-matter of his application was ever before known or used prior to his invention, and that he is a citizen of the United States and resident of Hyde Park, Mass.

JAMES A. TILDEN.

Sworn to and subscribed before me this nineteenth day of December, 1884.

F. F. RAYMOND, 2D,
Justice of the Peace.

[Endorsed:] Serial No., 150,909. Paper No. 1. Application. Filed Dec. 22, 1884. United States Patent Office, Dec. 22, 1884.

* In pencil in copy.
† Figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

444 Room 98.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *March* 7, 1885.

J. A. Tilden, care Clarke and Raymond, 29 Pemb. Sq., Boston, Mass.

No. 150,909. Fluid meter. Filed Dec. 22, '84.

Where is "line *z z*," upon which Fig. 5 is said to be a vertical section?

Page 5, "Fig. 23" should read Fig. 22.

Claims 1, 2, 3, 4, 5, 6, 7, and 8 are anticipated in patents No. 211,769, Jan. 28, '79; No. 211,582, Jan. 21, '79, and No. 281,390, July 17, '83, to Nash in rotary meters. Claim 9 is anticipated in patent No. 12934, to Barden in piston meters, May 22, '55. Claims 12 and 18 are anticipated in patent No. 264,702, to Johnson, Sept. 19, '82, in rotary meters. Claims 14, 15, and 16 do not contain enough elements to form a combination productive of any result. Claims 11 and 13 conflict with paragraph beginning with line 11 of page 11, and are therefore rejected.

F. A. SEELY, *Ex'r.*

G. S. ELY,
4th Ass't Ex'r.

[Endorsed:] Serial No., 150,909. Paper No. 1. Rejection. Dated Mar. 7, 1885.

445 Examiner's Room 98.

UNITED STATES PATENT OFFICE.

James A. Tilden. Improvement in meters. Filed December 22, 1884. Serial No., 150,909.

29 PEMBERTON SQUARE, BOSTON, *April* 15, 1885.

Commissioner of Patents, Washington, D. C.

SIR: We have office letter of March 7th concerning this application, and in view of its contents we make the following amendments:

The line *z z*, upon which the section shown in Fig. 5 is taken, is represented by dotted lines in Fig. 4, and if the lines are not so represented the examiner is respectfully requested to add such letters to the figure.

On page 5, where reference is made to Fig. 23, meaning Fig. 22, the examiner is desired to erase "23" and insert in lieu thereof "22."

The first 8 claims are alleged to be met by patents No. 211,769, 211,582, and 281,390 to Nash.

We have carefully examined these patents. In fact, we may say

that we had full knowledge of them before the applicant's
446 specification was prepared, and we would respectfully call the examiner's attention to the very material differences which exist between the construction and operation of the applicant's meter and the construction and operation of the meter described in said patents, and which is generally known to the trade as the Crown meter.

The essential or distinct elements or features of the applicant's construction are these:

1. The main chamber of the meter or that which contains the piston has spaces or recesses, each of which has an individual or separate inlet port and an individual or separate exhaust port—that is, each of the measuring spaces or recesses which open from the main chamber of the piston have their separate or distinct means by which water or liquid is fed or supplied to them and by which it is prevented from [lifting]* leaving A the space or recess while it is filling. We understand that the Nash patents do not show or describe this feature.

2. The applicant's meter has a piston or valve upon which is formed lobes or projections, which are arranged or adapted to enter said measuring recesses or spaces, there being one lobe or projection for each recess or space, which lobe or projection is confined in its operation to said recess or space. In other words, it does not co-operate with any other of the measuring recesses or spaces. The Nash patents, as we understand them, do not describe this arrangement or construction.

3. The applicant's meter has a chamber from which extends the measuring spaces or recesses, each of which has a separate inlet port and a separate exhaust port, and a piston having a separate lobe or projection for each of the measuring spaces or recesses, each of which lobes is used only in connection with its respective measur-
447 ing space or recess and each of which controls its respective exhaust port or passage or the exhaust port or passage of the space or recess in which it is used, so that the same measuring space or chamber, [and]* the same exhaust port, and the same lobe A are always used A in connection with each other [and not in connection with their lobe].* This construction is not found described in said Nash patent.

4. The applicant's meter does not contain a piston or valve which revolves. The piston or valve does not revolve, as each lobe or projection thereof at no time co-operates with or works in *an* any other measuring space or recess than the one with which it is first arranged to work. In the Nash patents the piston is in constant rotation, and its projections are constantly successively entering [the]* successive spaces or recesses.

5. The applicant's meter has a piston which forms contacting points with the side of the chamber in which it is held [and]* upon one A at any one time, [its]* side only A so that the chamber is not divided into two sec-

* Words enclosed in brackets erased in copy.

tions or spaces of substantially similar size by contact of [the]* opposite points of the piston with the wall of the chamber; and, while the operation of the piston is such that it divides the chamber into successively formed receiving and discharge spaces or chambers of substantially the size of one of the measuring recesses or spaces [which are successively formed, but which],* they ʌ are not made by the rotation of the piston upon its axis, but by a reverse movement of the piston, which brings the contact points thereof backward from the position which they are in when each chamber or space has been successively emptied to a point which enables each chamber or space to be again filled, so that the piston, while it operates to discharge the liquid from successive measuring spaces or re-
448 cesses, cannot be called a rotating piston, but rather a reciprocating piston, which brings in successive order the same contacting surfaces into contact with the same surfaces of the wall of the ʌ chambers in which the [meter]* lobes of the piston ʌ move.

It will be seen from the above that we are now very far from the construction of the devices and their operation described in the said Nash patents.

6. The applicant's meter, as above indicated, has a piston which partakes more of the character of a reciprocating piston in emptying or discharging the various measuring spaces or chambers of the meter than of a rotating piston or valve, and it will be seen that from the very necessities of this construction the piston or valve is not restricted in its movement at any points but the contacting points, and that as these contacting points are always ʌ at any one time upon the same side of the piston, there is very little friction between the piston and the walls of the chamber which holds it, and that no dirty water or sediment can in any way interfere with the movement or action of the piston or valve or can to any appreciable extent add to the amount of the friction thereon. The freedom which is given the movement of the piston or valve in the chamber prevents the accumulation of sediment and prevents it from being at any time so placed that it can interfere with the prompt and proper movement of the piston, and the escape ports are so arranged that the sediment cannot collect in the measuring spaces or chambers.

This feature is certainly not discoverable in the Nash patents. Any sediment or foreign matter received in the [piston]* chamber of the Crown meter ʌ adds very materially to the friction upon the piston and is very
449 likely to be wedged between the ʌ [passage]* [piston]* contacting points of the piston and the wall of the meter, and when so wedged the ʌ piston ʌ action of the [has to stop its action].* stops.

7. The applicant's piston is operated or caused to take the movement that it does and its contacting points are brought into connection with the wall of the measuring chamber by means of the

* Words enclosed in brackets erased in copy.

water pressure, which is always behind the portion of the piston which is outside and not included within the said contacting points, and there is always a full head of water in the piston chamber. In other words, the inlet ports or entrances are at no time controlled by the lobes of the piston.

The Nash patents do not specify such a construction as this.

It will therefore be seen from these statements that very great and important distinctions in principle of construction exist between the applicant's invention and that described in the patents referred to, and as it may be possible to embody these distinctions more clearly in the claims and make them more apparent in the specification we will amend the application further as follows:

Insert after the last paragraph of the page immediately preceding the claims the following:

"It will be seen that the contacting points or lines of the piston or valve are, in the operation of dividing the chamber
A. into measuring spaces or recesses and discharging the same, always upon the [same]* one side of the piston, and that these contacting points are brought successively into operation, not
450 by the rotation of the piston or valve, but by their successive reverse movements, so that the piston or valve, while appearing more like a rotating piston or valve, is in principle more like a reciprocating piston or valve, in that each of its lobes or projections is caused to enter a measuring space or recess, advance therein, empty it, and return to its original position, to again advance in the said space or recess and empty, [and that]* in making this movement the contact between each lobe and the wall is not maintained during the reverse movement of each lobe or projection.

"It will further be seen that by this construction, the contacting points always being upon one side of the piston and the piston being held against the wall of the chamber by the water pressure behind, or that not included within the contact lines, that it is very loosely fitted within the chamber, so loosely, indeed, that it is free to be moved back and forward
A. therein the depth of a measuring space or chamber and is dependent upon the water pressure for maintaining the proper contact with the walls of the chamber and for its operation. It will further be seen that from this principle of construction there can be very little friction between the running parts, and that sediment or foreign substances cannot interfere with the fine and regular working of the device.

"It will also be noticed that the piston in other respects has more of the principle of a reciprocating piston than of a rotating piston, in that each lobe or projection operates as a separate or distinct piston or discharging device in connection with its respective space

* Words enclosed in brackets erased in copy.

or recess, so that, the recess or space being filled with liquid, the lobe enters it and presses the liquid therefrom through the exhaust port. In other words, each lobe or projection does not act to
451 displace the liquid from the spaces or recesses, but to discharge the liquid therefrom by an advancing movement from one end of the chamber or recess to the other."

The first eight claims are erased and the following substituted in lieu thereof:

"1. In water meters, pumps, or motors, a chamber having the spaces or recesses, each of which has a separate inlet port and a separate exhaust port, with a piston having a lobe or projection for each of said spaces or recesses, arranged to enter its said space or recess and to be used only therewith and to have the movement in relation thereto specified, all substantially as and for the purposes described.

Substitute F, June 6, '85. B.

"2. In a water meter, pump, or motor, a chamber having recesses or spaces opening therefrom, in combination with a piston having a separate lobe or projection for each of said recesses or spaces, which lobe or projection is arranged to enter its individual space or recess, is used only therewith and describes a continuous movement in relation thereto, and is adapted to be brought or moved into and out of contact with the wall of the space or recess, all substantially as and for the purposes described.

"3. In a water meter, pump, or motor, the combination of the piston chamber having spaces or recesses opening therefrom, each of which has an inlet port and an exhaust port, a piston having a lobe or projection for each space or recess adapted to describe therein a separate path and to control a separate exhaust port or passage, all substantially as and for the purposes described.

452 "4. In a water meter, motor, or pump, a piston chamber having recesses or spaces opening therefrom, each of which has an exhaust port, in combination with a piston having a *a* lobe or projection for each of said spaces or recesses, each of which describes a separate path in its respective space or recess and successively opens and closes its exhaust port, all substantially as and for the purposes described.

"5. In a water meter, motor, or pump, the piston chamber having spaces or recesses forming a part thereof, a piston, F, having a separate projection or lobe for each of said spaces or recesses, which is adapted to operate in connection with its respective spaces or recesses, as specified, and which is brought successively with the other lobes into operating position with a register and connecting devices actuated by the motion of the piston, all substantially as and for the purposes described.

"6. In a water meter, motor, or pump, the piston chamber having spaces or recesses forming a part thereof, a distributing chamber, connecting passages or inlet ports which

B.

Words and sentences enclosed between rules erased in copy.

connect the distributing chamber with the measuring chamber and which are uncontrolled, a piston having lobes or projections which enter the spaces or recesses of the piston chamber, each of which has a continuous motion in relation to its respective space or recess, all substantially as and for the purposes described.

"7. In a water meter, motor, or pump, the combination of the inlet, a distributing chamber, a^2, the piston chamber D, having the recesses or spaces d, the inlet ports E, the piston F, having a separate lobe or projection for each space or recess and
453 used only therewith, the escape ports and outlet a^3, all substantially as and for the purposes described.

"8. The water meter, motor, or pump having the base section containing the inlet and outlet passages, the distributing chamber a^2, the piston chamber D having the recesses or spaces d, the piston F having a lobe or projection for each of said spaces or recesses, all substantially as and for the purposes described."

The 9th claim is said to be met by patent No. 12934, dated May 6, 1855. We have carefully examined this patent and do not find therein the combination set forth in this claim. There is not shown in the said patent the section A having a common distributing chamber, nor a section B having a removable port plate. This claim may be amended, however, by inserting after "port plate B," 2d and 3d lines, the words "having the ports E."

The 12th claim is erased.

The remaining claims are advanced one in number.

It is believed that the 13th, 14th, 15th, and 16th claims contain a sufficient combination of elements to make a legitimate combination, because they contain enough to make a very useful one. The construction which is sought to be covered in these claims is of very material consequence, in that a meter [motor]* provided with it is not only very much more durable, but can be more cheaply made and renewed. The wearing portions of the meter should, of course, be made of durable and non-corrodable material. Such material is generally expensive, and it is, of course, not desirable that
454 the entire structure or casing of the meter be made of this more expensive material in order to provide proper wearing parts if it is possible to combine the parts to secure the results in any other way.

The applicant has been able to so construct his meter as to obtain this very desirable result. The port plates are made of composition not corrodable. The wall of the chamber is made removable and of material having a proper wearing qualities. These port plates and the removable wall are secured in an iron casing or shell so as to be easily removable therefrom, and the combinations set forth in the above claims relate to these features of the construction.

A careful examination of the Johnson patent, cited as meeting the original 18th claim, fails to show to us that the elements of this claim

* Word enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

are found therein, and if, in view of what we have already said, the examiner is still of the opinion that it does, we would respectfully ask him to indicate the portion of the Johnson device which he considers to be the same.

We also submit new claims as follows:

18. In a water meter, motor, or pump, a piston chamber having spaces or recesses and a piston having lobes or projections extending therefrom to form, in connection with the wall of the chamber, contact surfaces upon one side of the piston or valve at one time only, whereby the piston or valve may be loosely fitted in the piston chamber and whereby [it is]† lines or points of contact are successive[ly contacted]† ʌ with the wall of the chamber [is]† ʌ obtained and maintained by the water pressure acting upon the portion of the valve or piston without the contact points, all substantially as and for the purposes described.

Canceled June 6, '85. C. Too much function.*

455 19. In a water meter, pump, or motor, a piston chamber having spaces or recesses, in combination with a piston having lobes or projections which are brought in contact upon the movement of the piston with the wall of the chamber and which are moved while thus held in contact with the said wall a limited distance and are then caused ʌ [to pass]† to be returned, to be again passed over the same contacting surfaces, all substantially as and for the purposes described.

20. The combination, in a water meter, motor, or pump, of a piston chamber having measuring spaces or recesses extending therefrom, with a piston having lobes or projections which enter said recesses or spaces and are successively caused to have a sweeping movement therein and to maintain during such sweeping movement a contact with the wall of the recess or space, all substantially as and for the purposes described.

21. The combination, in a water meter, motor, or pump, of a piston chamber having the measuring spaces or recesses extending therefrom, with a piston having lobes or projections which enter said spaces or recesses and are caused to have in succession a sweeping movement therein and to maintain during such sweeping movement a contact with the wall of the recess or space ʌ and actuated by water under pressure, as specified, whereby the piston is caused to travel around the chamber to establish successive contact points without revolving on its axis, all substantially as and for the purposes described.

Very respectfully, CLARKE & RAYMOND,
Att'ys for James A. Tilden.

* In pencil in copy.
† Words enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

[Endorsed:] Serial No., 150,909. Paper No. 2. Am'd't- A, C. Filed Apr. 18, 1885. United States Patent Office, Apr. 18, 1885.

456 Room 98.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *April* 25, 1885.
Mailed " 27, "

J. A. Tilden, care Clarke & Raymond, 29 Pemb. Sq., Boston, Mass.

No. 150,909. Fluid meter. Filed Dec. 22, '84.

It is not evident to the examiner that the train of gears described on page 7 will accomplish any such result as stated, namely, of reducing motion of rotation to $\frac{1}{80}$.

Paragraph on page 11 and claims 11 and 12 are still all in the case, and therefore claims 11 and 12 are objected to as before. Claims 13, 14, 15, and 16 are rejected, as before, as involving nothing more than a tin box in a paper box. Claim 17 is rejected as before on patent to Johnson. In Fig. 1 of the Johnson patent M indicates a reducing train of gears between the water wheel and the registering mechanism.

By an inadvertence patent No. 313,860, to Gaskill, March 17, '85, in rotary meters, has been issued, and such patent involves a structure and a claim which appear to interfere with the present application. If desired, the applicant can have an interference or he can restrict himself so as to avoid such patent. Claims 1–8 and 18–21 would appear to conflict with said patent to Gaskill.

F. A. SEELY, *Ex'r.*

G. S. ELY,
4th Ass't Ex'r.

[Endorsed:] Serial No., 150,909. Paper No. 3. Rejection. Dated Apr. 25, 1885.

457 Examiner's Room 98.

UNITED STATES PATENT OFFICE.

James A. Tilden. Imp. in meters. Se. No., 150,909. Filed Dec. 22, 1884.

WASHINGTON, D. C., *June* 5, 1885.

Hon. Comm'r of Patents.

SIR: We amend this case, in view of office letter of April 25 and after conference with the examiner, as follows:

On page 7 erase in line "80" and insert in lieu "81."

On page 11 erase the third paragraph.

Amend the specification by inserting before the preamble, "Having thus fully described," etc., as follows:

It will be seen that the piston is made to fit [a]* the piston chamber loosely, and [with]* that the necessary contact between its contacting surfaces and the wall of the chamber is obtained and maintained by so arranging the contacting points and the admission of pressure to the chamber that there shall always be a sufficient area of the piston exposed to the direct pressure to cause it to overcome all resistance and to keep it
D. in contact with the wall of the chamber while it is being moved.

I have shown in Fig. 19 a diagram which illustrates this feature of construction, giving for the form of piston and [a]* piston chamber therein shown the area of the piston upon which the direct pressure is exerted and the area upon which there is a resisting force, and it will be seen from the calculations noted upon said drawing that there is always an excess of pressure to maintain the piston in operation [ting it]*
458 in working position. The said diagram and calculations also show how the rotative effect is obtained.

In order that this result may be obtained it is not only necessary that the piston be loosely fitted, but that its surface should be substantially parallel with the surface of the piston chamber. It will also be seen that by forcing the piston against the wall of the chamber by excess of pressure from behind instead of drawing it to the wall of the chamber by a crank or other rigid mechanical device, that a substantially perfect contact must always insue and continue, and that the piston is constantly fitted to the wall of the chamber as it wears, the very action of wearing tending to give it a better fit, while if a crank or rigid connection be employed there is no compensation for wear or opportunity for it.

Another advantage which arises from this form of construction and operation is that the meter is kept free from sediment, and the accidental lodging of foreign matter on the
D. piston lobes or walls of the chamber cannot injure the meter or interfere with its practical working, as the lobe is pressed away by or rides over it, and it is then immediately washed off by the liquid.

It will also be observed that by making the wearing portions of the meter separate or detachable from the casing, as shown in Figs. 9 to 14, inclusive, that the casing can be made of cast iron and the wearing parts of more expensive, durable, and non-corrosive material, thereby less-ing the cost of construction, increasing the efficiency and life of the meter, and enabling repairs to be [chiefly, cheaply]* economically, and readily made.

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* Words enclosed in brackets erased in copy.

It will be observed that the reducing gearing and drum are contained in a recess within the piston, and that they are therefore within the piston chamber, and that by so arranging them less space is required than where they are placed without the piston chamber, as is generally the case.

Also amend specification by inserting, after line 31, page 7, as follows:

It will be seen by this construction of gearing that the drum g', carrying the gears g^7 g^8, revolves from left to right, and that the gear wheels g^7 g^8, being carried by the drum, are caused by the meshing of the gear g^7 with the stationary
E. gear g^6 to turn from right to left, and that the meshing of the gear g^8 as it is turned upon its revolution about the gear g^9 causes the gear g^9 to be moved, as above specified, one eighty-first of a revolution for each revolution of the drum and the gears g^7 g^8 about it.

The claims are amended as follows:
Erase claims 1 to 8, inclusive, and substitute the following:

459 1. In water meters, pumps, or motors, a piston chamber having the measuring spaces or recesses described, each of which has a separate inlet port and a separate outlet port directly connected therewith, as specified, in combination with a piston having a lobe or projection entering each of said spaces or recesses and adapted to be brought in contact with the walls of the chamber by the excess of pressure from behind, whereby the lobes are given the successive movements in their respective spaces or recesses indicated, all as set forth.

2. In a water meter, pump, or motor, a chamber having measur[ed]* ing recesses or spaces opening therefrom, in combination with a piston having a separate lobe or projection entering each of said recesses or spaces and adapted to be brought in contact with the walls thereof and to be held in contact therewith during the movement of the piston by the direct pressure exerted upon the piston, as specified, all sub-
F. stantially as set forth.

3. In water meters, pumps, or motors, the combination of a piston chamber having measuring spaces or recesses opening therefrom, each of which has an inlet port and an outlet port, with a piston having a lobe or projection entering each space or recess adapted to control the exhaust port thereof and to maintain a contact with the wall of the space or recess, which contact is maintained by the excess of direct pressure in the piston chamber, as described, all substantially as set forth.

4. In a water meter, motor, or pump, the piston chamber

* Letters enclosed in brackets erased in copy.

having measur[ing]* recesses or spaces forming a part thereof, a piston, F, having a projection or lobe entering each of said projections or lobes spaces or recesses, which ʌ are adapted to be brought successively into contact with the walls of said spaces or recesses and to be moved therein and the contact maintained during the discharge of the liquid ʌ from each space or recess by the direct pressure in the piston chamber, as specified, a register, and devices connecting the piston with register, all substantially as and for the purposes set forth.

460

5. In a water meter, motor, or pump, the piston chamber having measur[ing]* spaces or recesses forming a part thereof, a distributing chamber having an inlet, a', the passages or inlet ports E, connecting the distributing chamber with the measuring spaces or recesses of the piston chamber, a piston having a separate or distinct lobe or projection which enters each of said measuring spaces or recesses and is operated or moved ʌ [therein substantially as indicated,]* all substantially as and for the purposes described. and the contact maintained by the excess of pressure, as herein set forth,

6. In a water meter, motor, or pump, the combination of the distributing chamber a^2, its inlet a', the piston chamber D having measuring recesses or spaces d, the ʌ uncontrolled ports or passages E connecting the distributing chamber [E]* with the a^2 recesses or spaces d, the outlet ports E' and escape passages connected therewith, and the piston F, having the lobes or projections f, ʌ all substantially as described.

F.
Insert H, June 13, '85.

7. In a water meter, motor, or pump, the independent or separate base section containing the inlet passage a', the distributing chamber a^2, and the outlet passage a^3, with the independent or separate section B, containing the piston chamber D, with the measuring recesses or spaces d, connected with the distributing chamber and outlet passage, as described, and the piston F, having a lobe or projection for [entering]* each of said spaces or recesses, and the bolts for fastening the two sections of the meter together, all substantially as and for the purposes described.

The 9th, 10th, 11th, and 12th claims are advanced one number.

F. F. R.
"and" erased and "& 18" interlined.

& 18
Claims 13, 14, 15, 16, [and]* 17, ʌ are erased and the following substituted:

*Words enclosed in brackets erased in copy.

461 Cancelled June 13, '85.

12. In a water meter, motor, or pump, the removable wall of the piston chamber, made of non-corrodible material, in combination with the exterior casing or wall of the meter, all substantially as and for the purposes described.

13. The combination of the removable ports plates or either, made of non-corrodible material and forming the surfaces of the piston chamber, as described, with the wall or casing of the meter, all substantially as and for the purposes set forth.

14. The combination of the piston chamber D, having a removable wall of non-corrodible material, and the removable port plates with the outer wall or casing of the meter, and means for fastening the chamber wall and plates to each other and to the outer wall of the meter, all substantially as described.

G.

[15]* 12. The combination, in a water meter, of the piston chamber D, the piston F, the reducing mechanism or gearing for transmitting the motion of the piston to the registering device contained in a recess in the piston, and the registering mechanism, all substantially as and for the purposes described.

Substitute I, June 13, '85.

16. In a water meter, motor, or pump, a piston chamber having measuring spaces or recesses and a piston having lobes or projections extending into said spaces or recesses to form in connection with the walls the section of the piston between which being thereof successive contacting surfaces, A of less area than the area of the piston subjected to the direct action of the pressure from behind, whereby the piston or valve may be loosely fitted in the piston chamber and by the excess of pressure cause- by the difference in areas [is]* be A brought into contact with the walls of the spaces or recess; maintained in contact therewith, and rotated, all substantially as described.

The 19th, 20, and 21st claims are erased.

Very respectfully yours,

CLARKE & RAYMOND,
Att'ys for James A. Tilden.

[Endorsed:] Serial No., 150,909. Paper No. 4. Am'd't- D, G. Filed June 6, 1885.

* Word and figures enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

462 Examiner's Room 98.

UNITED STATES PATENT OFFICE.

James A. Tilden. Improvement in meters. Filed Dec. 22, 1884. Serial No., 150,909.

29 PEMBERTON SQUARE, BOSTON, *June* 10, 1885.

Commissioner of Patents, Washington, D. C.

SIR: After further conference with the examiner in relation to this case and in view of his request it is amended as follows:

The 6th claim is amended by inserting after "lobes or projections *f*," 6th line thereof, as follows:

H. "One for each of the measuring spaces or recesses *d*, and operated or moved therein to maintain contact during the discharge of the liquid from each space [of]* or A recess by the direct pressure in the piston chamber, as specified."

The 7th claim is amended by erasing, after "lobe or projection for," 7th line, "entering."

The 12th, 13th, and 14th claims are withdrawn, but the applicant reserves the right to renew them in a separate application.

463 The 15th claim is renumbered 12.

The 16th claim is erased and the following, which contains the suggestions of the examiner, substituted therefor. It is renumbered 13.

I. "13. In a water meter, motor, or pump, a piston chamber having measuring spaces or recesses and a loosely pitched A piston having lobes or projections extending into said spaces or recesses to form, by contact with the walls thereof, successive discharge spaces, the said walls being shaped to provide [a]* the surface of the piston within the contacting lines of the discharge spaces with less area than the remainder of the piston subjected to the direct action of the pressure from behind, whereby the piston or valve may be loosely fitted in the piston chamber and by [an]* the A excess of pressure caused by the difference in area[s]* is brought in contact with the walls of the measuring spaces or recesses, maintained in contact therewith, and rotated, all substantially as described."

In answer to the examiner's request for a model we would say that we have to-day forwarded one, complete in every respect, by the Adams Express Co.

Very respectfully, CLARKE & RAYMOND,
Att'ys for James A. Tilden.

[Endorsed:] Serial No., 150,909. Paper No. 5. Am'd't- H, I. Filed June 13, 1885. United States Patent Office, Jun- 13, 1885.

---

* Words enclosed in brackets erased in copy.

464 (2-024.)

Reissue division. Serial No., 150,909.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., *June 20th*, 1885.

James A. Tilden, ass'or, c. o. Clarke & Raymond, Boston, Mass.

SIR: Your application for a patent for an improvement in rotary fluid meters, filed Dec. 22d, 1884, has been examined and allowed.

The final fee, twenty dollars, must be paid, and the letters patent bear date as of a day not later than six months from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld and your only relief will be by a renewal of the application, with additional fees, under the provisions of section 4897, Revised Statutes. The office aims to deliver patents upon the day of their date and on which their term begins to run, but to do this properly applicants will be expected to pay their final fees at least twenty days prior to the conclusion of the six-months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts preparatory to final signing and sealing will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor and title of invention as above given, date of allowance (which is the date of this circular), date of filing, and, if assigned, the names of the assignees.

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

Additional copies of specifications and drawings will be charged for at the following rates: Single copies, uncertified, 25 cents; twenty copies or more, 10 cents each. The money should accompany the order.

Very respectfully, M. V. MONTGOMERY,
Commissioner of Patents.

[Printed across the face in red ink:] In remitting the final fee give the serial number at the head of this notice.

[Printed on margin in red ink:] The within title is that given by the examiner in charge as most appropriate to your invention. Should you desire a change in the same, satisfactory reasons must be given therefor on or before the payment of the final fee.

465 (2–137.)

Memorandum of Fee Paid at U. S. Patent Office.

$20. C.
Serial No., 150,909. 1884.
Inventor:
James A. Tilden.
Patent to be issued to:
Hersey Bros.
Name of invention as allowed:
Rotary fluid meters.
Date of payment:
July 27, 1885.
Fee:
$20.00.
Solicitor-:
Clarke & Raymond.
Date of filing:
Dec. 22, 1884.
Date of circular of allowance:
June 20, 1885.
Send patent to:
Clarke & Raymond, 29 Pemberton Sq., Boston, Mass.

[Endorsed:] U. S. Patent Office, Jul- 29, 1885. By mail.

466 1884.

Serial No., 150,909. Ex'r Book No. $\frac{173}{5040}$.

Patent No. 324,503. Seely.

"Firm." James A. Tilden, ass'or to Hersey Brothers, of Boston, Mass.,
Of Hyde Park,
County of Norfolk,
State of Massachusetts.

Invention, fluid meters.

Parts of application filed.
- Petition, Dec. 22, 1884.
- Affidavit, " " "
- Specification, " " "
- Drawing, 8 sheets, " " "
- Model, June 13, '85.
- Specimen, ——.
- First fee, cash, $15, Dec. 22, 1884.
- 1. " " cert., —.

App. filed complete Dec. 22, '84.
2. Examined June 18, 1885. Seely.
Countersigned: June 20, '85. J. W. Babson, for Commissioner.
Notice of allowance, June 20, 1885.
3. Final fee: Cash, $20, July 29, 1885.
" " cert., 188–.
Patented Aug. 18, 1885.
Att'y or P. O. address, Clarke & Raymond, 29 Pemb. Sq., Boston, Mass.

Reissued Nov. 2, 1886. No. 10778.

467 1884. C.*

Contents.

½. Application, 2 papers.
1. Mar. 7, '85, rej.
2. Apr. 18, '85, am'd't- A, C.
3. April 28, '85, rej.
4. June 6, '85, am'd't- D, G.
5. " 13, " " H, I.
6. June 18, '85, brief.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

Title:
Improvement in rotary fluid meters.
78. Measuring instruments.
Rotary meters.
Rotary meters.*

Comp'd by—
M. F. Moore.
E. L. Layne.
[Endorsed:] 10751. D.,'88.

---

* In pencil in copy.

476 UNITED STATES PATENT OFFICE.

JAMES A. TILDEN, of Hyde Park, assignor to Hersey Brothers, of Boston, Massachusetts.

Rotary Fluid-Meter.

Specification forming part of Letters Patent No. 324,503, dated August 18, 1885. Application filed December 22, 1884. (Model.)

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid-meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification in explaining its nature.

It is well known that a fluid-meter to be commercially successful must be capable of perfectly measuring or indicating the quantity of fluid which passes through it, regardless of the size of the stream, its speed, head, or any other condition, that it must not easily get out of repair, that its construction must be simple, and its manufacture inexpensive, and various meters have been made with some if not all of these conditions, but, so far as I am aware, there is not at present in the market any meter which combines all of these features with certain necessary wearing qualities to such an extent that it may be said to be a really commercially successful or practical meter; and while my invention may not be perfect in every respect, yet it has all the requisites of an efficient, desirable, and cheap meter.

The principle upon which the meter is constructed is so simple that but very few parts or pieces are necessary and very little machine-work required in fitting them, and these can be placed in such very small compass that the weight of metal necessary for the casing is very small.

The invention comprises, broadly speaking, a chamber having inlet and exhaust ports, and a piston for opening and closing the exhaust-ports. The meter can hardly be called a "rotary" meter, because the piston does not rotate, and yet it is quite unlike in appearance any of the ordinary reciprocating-piston meters; but it combines, it may be said, portions of both systems in substantially this manner. The measuring-chamber of the meter is divided or separated upon its outer edge into measuring spaces or recesses, all of which open into the central portion of the chamber, but which may or may not be of uniform size and shape. Each of these spaces has its individual inlet and exhaust ports. The part which I call the "piston" has a radially-extending portion or lobe, which enters each measuring space or recess and does not at any time leave it, and has a movement therein that causes it to be brought into contact with one side of each recess near the mouth and to advance

along the side continuously until it reaches the other side of the recess, when it returns across the mouth of the recess or space to its original position. This movement of each lobe in each space or recess alternately exposes and closes the exhaust ports, thereby preventing the flow of liquid from the chamber only after it has entered what may be termed the "measuring" and "discharging" spaces or recesses. The sides of the chamber and the sides of the piston should be parallel when the piston is centrally located in the chamber.

To understand the working of the device, it must be borne in mind that the liquid has free access to the chamber—that is, its inlet-ports are never entirely closed—that because of the shape of the wall of the chamber and of the piston, the piston is kept in contact with the wall of the chamber at a number of what I call "contact" points or lines, which form in the measuring and discharging passages spaces or recesses. The number of lines of contact depend, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary, because a full head is maintained in the larger part of the chamber, and it is of course necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by liquid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes in connection with the portions of the wall which constitute or form the spaces or recesses also act to separate the exhaust-ports from the inlet-ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact-lines, one between the outer surface of the lobe and the wall of the recess and the other between the surface of the inward projection of the wall and the surface of the piston between the lobes. These lines of con-
477 tact continually advance until the water has been expelled from each space or recess. While, however, this discharge from each space or recess is going on by the movement of the lobe, the space or recess is filling behind the lobe. Of course the number of spaces or recesses which are discharging simultaneously depend upon the entire number of spaces or recesses which the chamber contains, and there may be several recesses or spaces discharging and receiving at the same time. This advancing movement of the lobe in each space or recess does not continue beyond its individual space, but upon reaching the end of that space or recess it returns across the mouth or entrance of its recess or space to its original position, while the piston as a whole, without revolving, moves on a circular path.

In the drawings—

(Here follow diagrams marked pp. 468, 469, 470, 471, 472, 473, 474, and 475.)

(Model.) 8 Sheets—Sheet 1.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

No. 192. Natl Meter Co. } p. 468.
" Bd Water Comrs

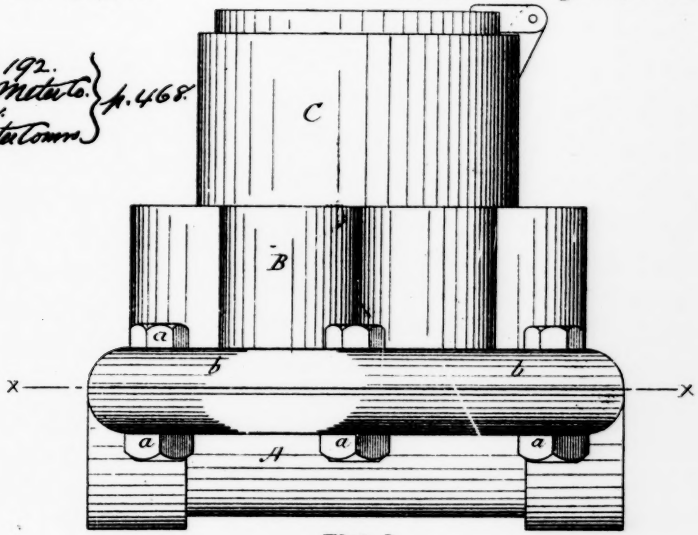
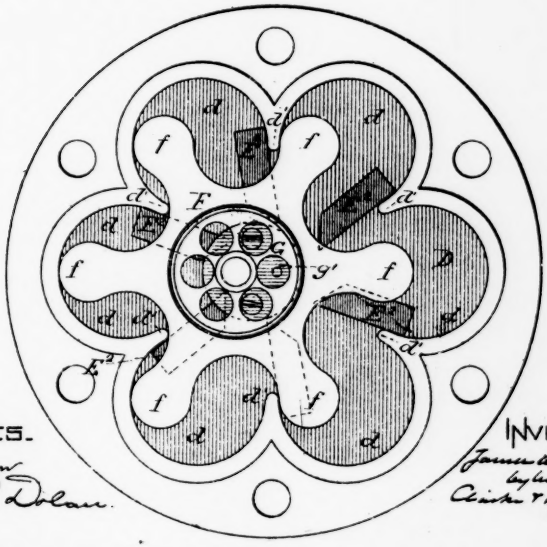


Fig. 1.

Fig. 2.



WITNESSES.
J. M. Dolan
Fred. B. Dolan.

INVENTOR.
James A. Tilden
by his attys
Clarke & Raymond.

(Model.) 8 Sheets—Sheet 2.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

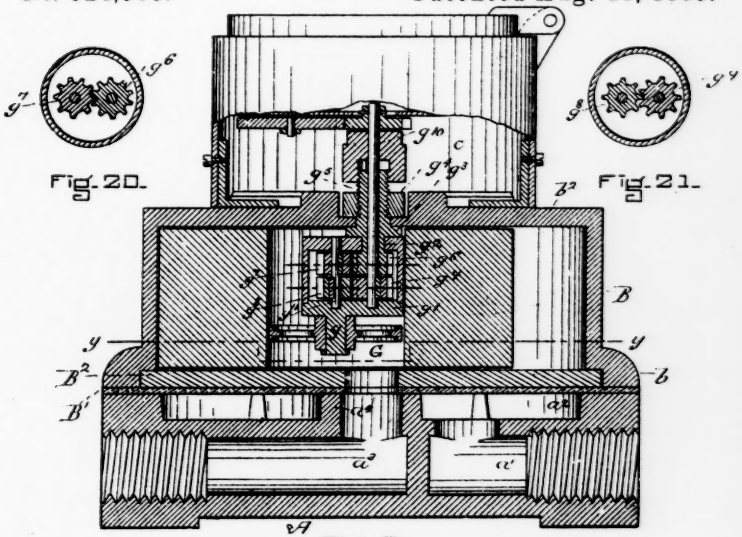


Fig. 20. Fig. 21.

Fig. 5.

No. 192.
Nash Meter Co. } p. 469.
v.
Bd. Water Comrs.

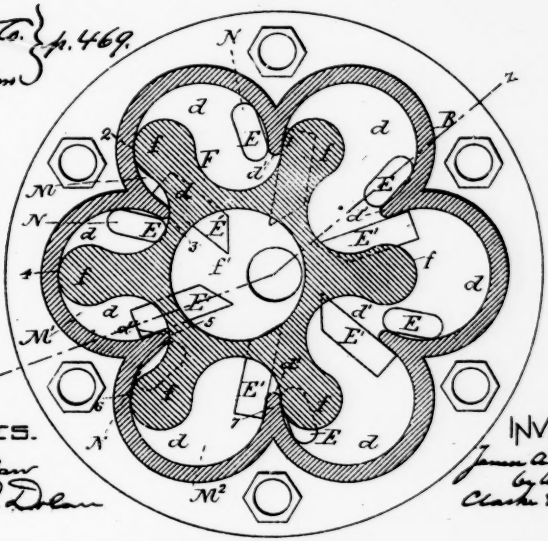


Fig. 4.

WITNESSES.
J. M. Dolan
Fred. P. Dolan

INVENTOR.
James A. Tilden
by his atty
Charles F. Raymond

(Model.) 8 Sheets—Sheet 3

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

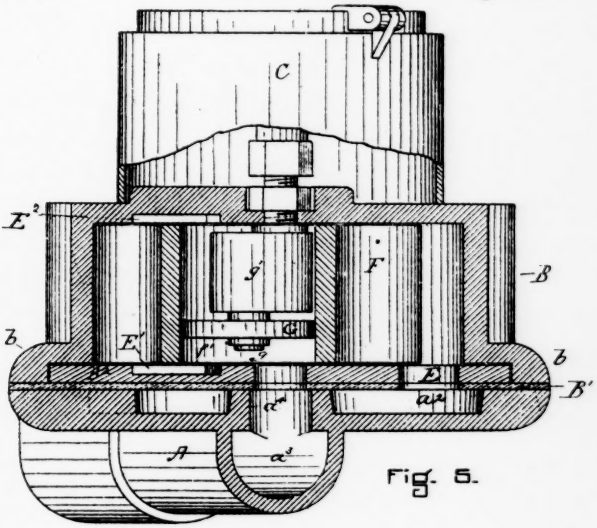


Fig. 5.

No. 192.
Natl Meter Co.
v.
Ad Water Comm
} p. 470.

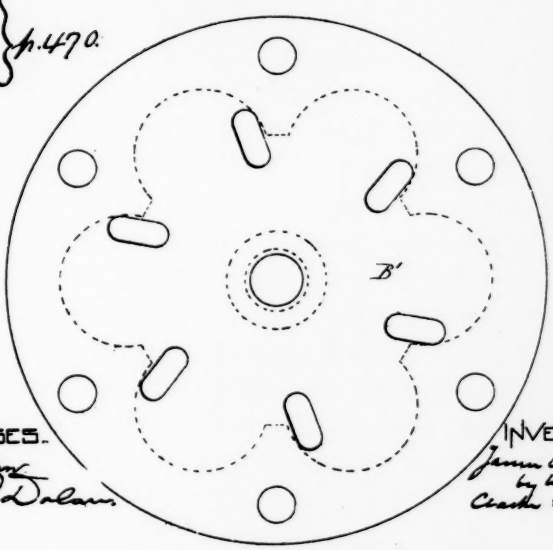


Fig. 6.

WITNESSES.
H. No. Dolan
Fred C. Dolan.

INVENTOR.
James A. Tilden
by his attys
Church & Campbell.

(Model.) 8 Sheets—Sheet 4.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

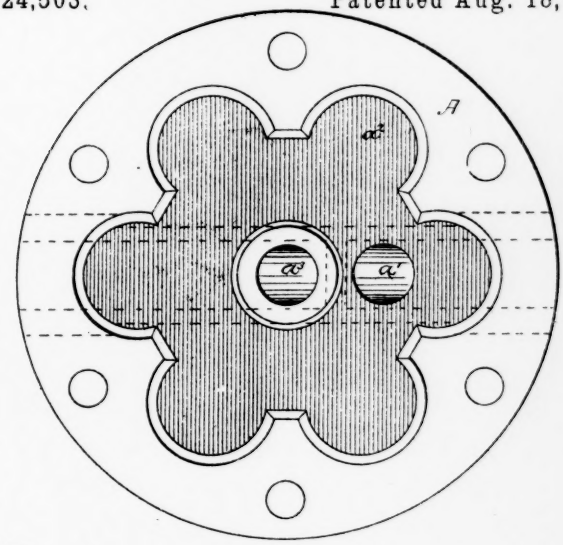


Fig. 7.

No. 192.
Natl Meter Co.
v.
Old Water Comp.
p. 471.

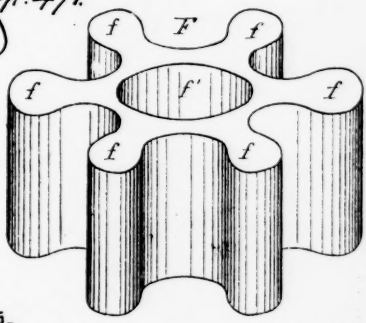


Fig. 8.

WITNESSES.
J. M. Dolan
Fred. B. Dolan

INVENTOR.
James A. Tilden
by his attys
Cushman & Raymond.

(Model.) 8 Sheets—Sheet 5.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

No. 192
Natl Water Co.
v.
Od Water Comrs.
p. 472

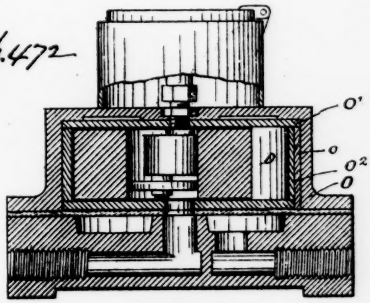


Fig. 9.

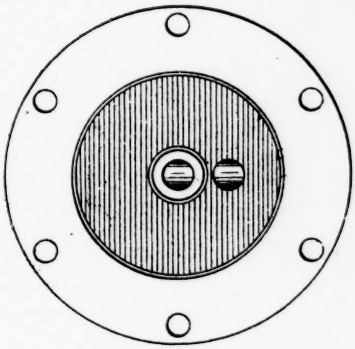


Fig. 10.

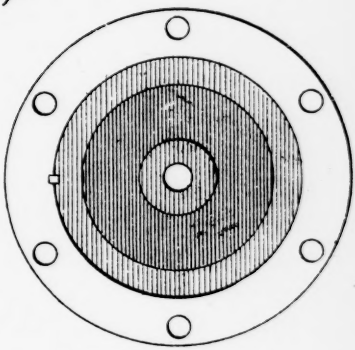


Fig. 11.

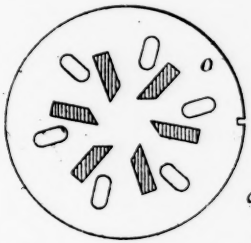


Fig. 12.

WITNESSES.
J. M. Dolan
Fred. B. Dolan.

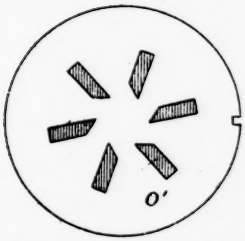
INVENTOR.
James A. Tilden
by his attys
Clarke & Rigmond.

(Model.) 8 Sheets—Sheet 6.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.



No. 192.
Natl. Meter Co.
v.
Ad. Water Comrs
p. 473

Fig. 13.

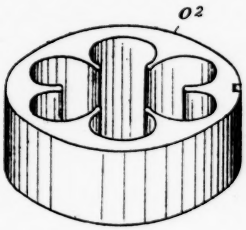


Fig. 14.

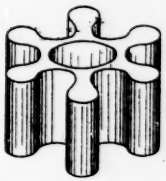


Fig. 15.

Fig. 22.

WITNESSES.

J. M. Dolan

Fred. B. Dolan.

INVENTOR.

James A. Tilden
by his attys
Crosby & Raymond.

(Model.)

ets—Sheet 8.

J. A. TILDE

ROTARY FLUID ME

No. 324,503. Pa

8, 1885.

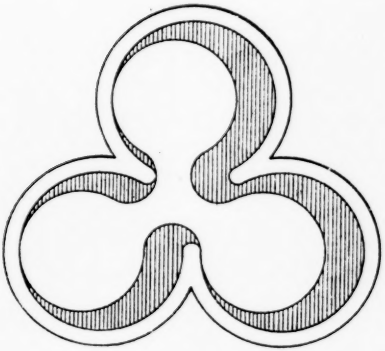


Fig. 16.

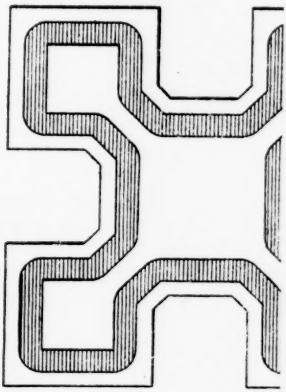


Fig. 18.

WITNESSES.

J. Wm. Dolan

Fred. C. Dolan

ENTOR.

Tilden

atty

Raymond.

(Model.) 8 Sheets—Sheet 7

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

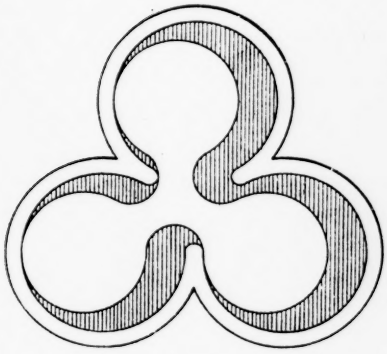


Fig. 16.

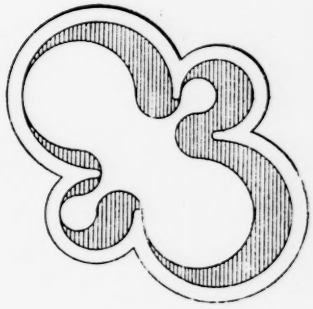


Fig. 17.

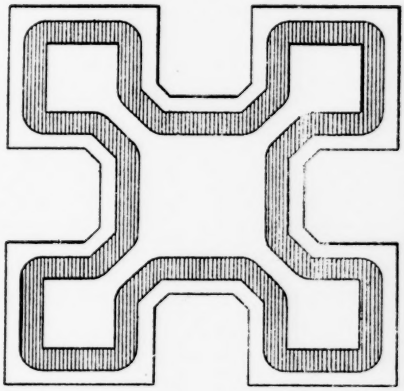


Fig. 18.

No. 192.
Natl Meter Co.
v.
Bd Water Comrs
p. 4.

WITNESSES.

J. M. Dolan
Fred. B. Dolan

INVENTOR.

James A. Tilden
by his attys
Charles H. Raymond.

(Model.) 8 Sheets—Sheet 8.

J. A. TILDEN.

ROTARY FLUID METER.

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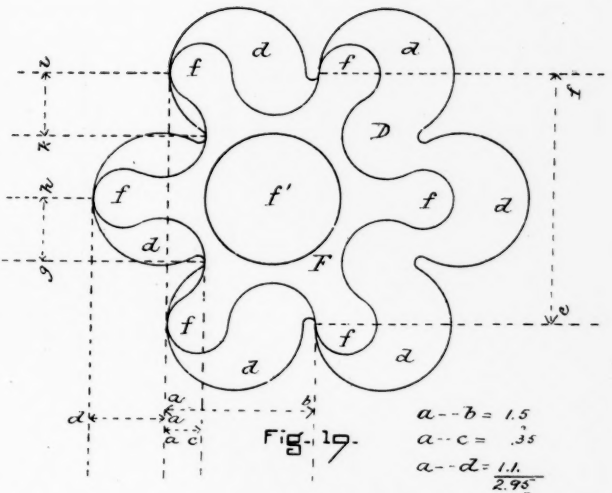

Fig. 19.

a--b = 1.5
a--c = .35
a--d = 1.1
2.95
1.5
Rotative effect 4.425 sq. in.

e--f = 2.6 × 1.5 = 3.90
g--h = .65
k--l = .65 / 1.30 × 1.5 = 1.95
Excess pressure 1.95 sq. in.

No. 192.
Natl Meter Co. v. Bd Water Comrs. } p. 475.

WITNESSES.
J. M. Dolan
Fred. B. Dolan

INVENTOR.
James A. Tilden
by his attys
Clarke & Raymond.

Figure 1 represents a side elevation of the machine. Fig. 2 is a plan view of a portion of the meter above the line $x\ x$ of Fig. 1, inverted, showing the piston and upper series of exhaust-ports. Fig. 3 is a view, principally in vertical central section, showing, especially, the mechanism for connecting the piston with the registering-train. Fig. 4 is a section upon the line $y\ y$ of Fig. 3 also showing the lower series of exhaust-ports and the inlet-ports. Fig. 5 is a view, principally in vertical section, upon the lines $z\ z$ of Fig. 4, showing, especially, the relation of the exhaust-ports, meter-walls, and spaces or recesses when discharging. Fig. 6 is a plan view of the packing-piece between the base and main sections of the meter. Fig. 7 is a plan view of the base-section, showing the receiving-chamber and the inlet and outlet passages. Fig. 8 is a perspective view of the piston. Figs. 9 to 15, inclusive, illustrate special details of a modified form of construction. Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction. Fig. 19 is a diagram showing by calculation the differences in pressure which cause the action of the meter. Figs. 20 and 21 are sections of the reducing-gears hereinafter described, and Fig. 22 is a view of the sleeve forming the support of the drum carrying the gears.

Preferably, the casing of the meter comprises three principal parts or sections—first, the base-section A; second, the body or main section B, and, third, the shell C, forming the chamber c, containing the registering mechanism.

The base-section is made somewhat larger in circumference than the main section, and the two parts are fastened together by bolts a, which pass through the flange b of the main section. The base-section has the inlet-passage a', which opens into the distributing-chamber a^2 and the outlet-passage a^3. The distributing-chamber a^2 occupies almost the entire upper portion of the base, and its object is to provide means for the ready distribution of fluid simultaneously through the various inlet-ports to the main chamber D.

Between the sections A B is a packing-ring, B′, which is shaped as shown in Fig. 6, and is provided with holes for the bolt-holes, the inlet-ports, and outlet-passage. Above this packing-ring is a metal plate, B^2, which may be called a "port-plate." It rests upon the packing-ring B′, and is held or fastened in place upon it and the upper surface of section A, surrounding the chamber a^2 and the central projection, a^4, by the bolts a, the plate being within the main section B and its edge projecting into a recess formed in the under edge thereof. This port-plate has the holes E, which form the inlet-ports to the chamber D and connect the distributing-chamber a^2 therewith. These ports E are arranged, preferably, to open into each space or recess d of the chamber D at one side thereof. The port-plate also has a central hole, which forms a portion of the outlet a^3 and the escape or exhaust ports E′, which are recesses formed in the upper surface of the plate, and arranged to extend from one side of each recess or space d inward upon converging lines. The chamber D has the measuring recesses or spaces d arranged about

its outer edge, which open into the central portion, and the projections or portions of the wall of the chamber which form spaces or recesses I have lettered d'. The piston F preferably is made of hard vulcanized india-rubber, gutta-percha, or other equivalent material, and has the wings or lobes f, which extend radially therefrom, and the central hole, f'.

For the best working of the device it is desirable, but not essential, that the surface of the piston, when the same is centrally located in the chamber D, shall be parallel with the surface of the chamber, so that as the surface of the chamber is made up of alternating recesses and projections, so the surface of the pistons is made up of alternating lobes and recesses. The central hole, f', of the piston forms a part of the exhaust or outlet passage, and is large enough to always permit the escape of fluid therefrom into the outlet a^3, regardless of the position of the piston.

In addition to the lower set of exhaust-ports, E'. I have formed in the under surface of the upper plate, b^2, which forms the top of the main section B, another set of exhaust-ports, E^2. (Shown in Fig. 2.) They are of the same shape and connect the same parts of the spaces or recesses with the opening f' as the lower exhaust-ports, E'. There is also arranged in the hole f' a perforated disk, G, (see Figs. 2 and 3,) by which motion is communicated to the shaft which operates the train of gears comprising the registering mechanism. This disk carries at its center a stud, g, which projects downward from the drum g', which is pivoted at g^2 to the screw-sleeve g^3, which passes through the hole in the plate b^2, and is locked thereto by the nut g^4, which screws upon the thread g^5, and the movement of the piston causes the drum to be revolved upon the
478 sleeve—that is, the drum and stud form substantially a crank.

It is necessary, however, as the chamber is of small capacity and as the motion of the piston is rapid, to reduce the motion of the piston very considerably, and it is desirable to do so in as simple a manner and with as few parts as possible, in order that the construction may be cheap and as little weight of metal used as possible; and I employ for this purpose a train of four gears, one of which, g^6, is stationary, being secured to the end of the sleeve g^3. The gears g^7 g^8 are attached to the drum by the shaft or pinion g^9, to which they are keyed, and the gear g^7 meshes with the gear g^6. The gear g^8 is arranged to mesh with the fourth gear, g^9, which is keyed or fastened to the spindle g^{10}, which communicates motion to the registering-train. As the drum revolves about the sleeve g^2, it is obvious that if the gear g^7 has more or less teeth than the gear g^6 it will be caused to move each revolution of the drum a certain portion of a revolution depending upon the difference in the number of teeth between the two gears. It is also obvious that if the gears g^8 g^9 have the same number of teeth as the gear g^7, a movement of rotation will be communicated to the shafts or spindle g^{10}. If it is desired to still further reduce or change the rate of the rotation of the shaft g^{10}, then the gear g^8 may have more or less teeth than the gear g^7, as the case may be, as also may the gear g^9; and in the drawings I have represented the gear g^6 as provided with ten teeth,

the gear g^7 with nine teeth, the gear g^8 with eight teeth, the gear g^9 with nine teeth, so that upon every complete revolution of the drum the shaft g^{10} is moved one eighty-first of a revolution, and it therefore requires eighty revolutions of the drum to make one complete revolution of the shaft, the spindle or shaft g^{10} being used, of course, to operate any registering mechanism.

It will be seen by this construction of gearing that the drum g', carrying the gears g^7 g^8, revolves from left to right, and that the gear-wheels g^7 g^8, being carried by the drum, are caused by the meshing of the gear g^7 with the stationary gear g^6 to turn from right to left, and that the meshing of the gear g^8, as it is turned upon its revolution about the gear g^9, causes the gear g^9 to be moved, as above specified, one eighty-first of a revolution for each revolution of the drum and the gears g^7 g^8 about it.

In operation the liquid passes into the distribution-chamber a^2 and through the inlet-ports E into the chamber D, moving the piston toward one side of the chamber and causing the formation of measuring or discharge spaces by the contact of the various portions of the piston with the chamber-wall. This position of the piston is well shown in Fig. 4, where there have been formed six divisions of the three spaces or recesses d by the contacting of the piston at the points 1, 2, 3, 4, 5, 6, and 7, and of these three recesses or spaces, two—namely, the small spaces marked M and the space M′—are connected by the discharge-ports E′ E^2 with the escape-passage, while the space M^2 is about to be; but the fluid, upon being admitted to the chamber under pressure, not only immediately moves the piston to the position shown in Fig. 4, which is one of any number of positions which it might cause it to assume, and from such position it causes it to advance or move, so that the lobes which are in contact with the wall of the chamber are caused to continue that contact until they have expelled all the fluid which is in the discharge spaces or recesses before them, when each lobe in succession will leave the surface and return upon an arc of a circle to a position where it again comes in contact with the surface of the wall of the chamber on the opposite side from that which it left, and again advances and expels the fluid from its recess or space.

It will be seen that each recess or space becomes in succession a discharge space or recess, and that as soon as the piston has moved sufficiently to uncover the inner end of its escape-ports it begins to discharge through such ports into the escape-passages b^3 a^3, and that while a portion of each space or recess is discharging another portion is also receiving the liquid under pressure through the ports E.

To illustrate why with the arrangement of the inlet and exhaust-ports described the piston is compelled to make the motion that it does, I have shown in Fig. 19 by diagrams the differences in pressure upon both sides of the piston and the extent of the surface which is subjected to the direct pressure of the entering fluid.

It is obvious that the chamber D, excepting the spaces which are discharging, is filled with fluid under pressure, and that the pressure for moving the pistons is that which enters each space or recess which is being discharged, and behind the respective discharging

lobe-. For instance, referring to Fig. 4, the piston is receiving motion from the fluid which enters the spaces through the ports marked N N N, but from no other. It is not necessary that the main chamber and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses, from three upward, and that they may be of any size and of different sizes for the same piston, the only difference to be observed being that the piston and chamber-wall must be so shaped as to provide the contact-lines in the surface of the piston or chamber-wall, whereby the formation of measuring-chambers is effected.

In Fig. 16 I have illustrated a piston having three lobes in a chamber having three measuring and discharge spaces or recesses. In Fig. 17 I have shown a piston with two large lobes and two small ones, and a chamber with corresponding recesses or spaces. In Fig. 18 I have represented the piston as having square lobes, and the chamber with spaces which substantially follow the shape of
479 the lobes, the only variation being that they are rounded at the corners.

It will be obvious from what I have stated that the meter is very simple in construction, that it has but very few parts, which require but little machine-work and are easily fitted and put together, and it is also apparent that a substantially-perfect registration of the liquid which passes through the meter is obtained, as it all is obliged to pass into the measuring-spaces, which are successively emptied. It will be seen, further, that this measuring of the liquid takes place very rapidly, and with comparatively very little friction of the wearing parts, and that the construction of the piston and chamber is such that sediment cannot interfere with the proper working of the invention, and that wear, up to a certain extent, improves the efficiency of the meter in that it causes the contacting surfaces of the piston and chamber to fit themselves as they wear.

To still further cheapen the manufacture I show in Figs. 9 to 15, inclusive, a construction which enables me to use, instead of the comparatively expensive casing of composition, an iron casing. This I accomplish by making the base-section entirely of iron, employing two composition port-plates, O O′, the plate O being like that described, and the plate O′ having simply the exhaust-passages E^2. The piston is made of hard rubber, gutta-percha, or other like non-corrosive material, and the wall O^2 (see Fig. 14) of the chamber D is formed of a ring or sleeve of gutta-percha, hard india-rubber, or even of composition, which is fitted into the iron shell or casing of the main section. This non-corrosive movable wall of the chamber is fastened to the casing by means of a key, *o*, which enters a groove in the ring and a corresponding one in the inner surface of the iron shell, or in any other suitable way. A view in perspective of the movable wall is shown in Fig. 14.

It will be seen that by this construction not only can an iron shell be employed, but that the principal wearing parts—namely, the port-plates, the piston, and the wall of the chamber—may be easily removed and others substituted therefor. The port-plates are also held in place by suitable keys or in any other desirable way, and it

will be observed that they extend upon the two end surfaces of the removable wall. (See Fig. 9.)

Of course the invention can be utilized as a pump or motor, if desired.

It will be observed that by making the mechanism for reducing the movement of the piston in compact form, I am enabled to place it in the measuring-chamber and within the hole formed in the piston, thereby economizing space.

As the gears are inclosed in a drum or casing, no sediment can reach them to disturb their easy action.

While the invention as shown in the drawings represents a piston which, while not rotating moves in a circular path, yet by changing the forms of the piston-lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, elliptical, or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston the principle of its action is not changed, as the lobe or portion of the piston which penetrates the measuring-space will have a continuous movement in said space, whether its path be circular, square, rectangular, elliptical, or of any other shape.

It will be seen that the contacting points or lines of the piston or valve are, in the operation of dividing the chamber into measuring-spaces or recesses and discharging the same, always upon the one side of the piston, and that these contacting points are brought successively into operation, not by the rotation of the piston or valve, but by their successive reverse movements, so that the piston or valve, while appearing more like a rotating piston or valve, is in principle more like a reciprocating piston or valve, in that each of its lobes or projections is caused to enter a measuring space or recess, advance therein, empty it, and return to its original position to again advance in the said space or recess and empty. In making this movement the contact between each lobe and the wall is not maintained during the reverse movement of each lobe or projection.

It will further be seen that by this construction the contacting points always being upon one side of the piston, and the piston being held against the wall of the chamber by the water-pressure behind, or that not included within the contact-lines, it is very loosely fitted within the chamber, so loosely, indeed, that it is free to be moved back and forward therein the depth of a measuring space or chamber, and is dependent upon the water-pressure for maintaining the proper contact with the walls of the chamber and for its operation.

It will further be seen that from this principle of construction there can be very little friction between the running parts, and that sediment or foreign substances cannot interfere with the fine and regular working of the device.

It will also be noticed that the piston in other respects has more of the principle of a reciprocating piston than of a rotating piston, in that each lobe or projection operates as a separate or distinct piston

or discharging device in connection with its respective space or recess, so that the recess or space being filled with liquid, the lobe enters it and presses the liquid therefrom through the exhaust-port. In other words, each lobe or projection does not act to displace the liquid from the spaces or recesses, but to discharge the liquid
480 therefrom by an advancing movement from one end of the chamber or recess to the other.

It will be seen that the piston is made to fit the piston-chamber loosely, and that the necessary contact between its contacting-surfaces and the wall of the chamber is obtained and maintained by so arranging the contacting-points and the admission of pressure to the chamber that there shall always be a sufficient area of the piston exposed to the direct pressure to cause it to overcome all resistance and to keep it in contact with the wall of the chamber while it is being moved.

I have shown in Fig. 19 a diagram which illustrates this feature of construction, giving *for* the form of piston and piston-chamber therein shown, the area of the piston upon which the direct pressure is exerted, and the area upon which there is a resisting force; and it will — seen from the calculations noted upon said drawing that there is always an excess of pressure to maintain the piston in operation in working position. The said diagram and calculations also show how the rotative effect is obtained.

In order that this result may be obtained it is not only necessary that the piston be loosely fitted, but that its surface should be substantially parallel with the surface of the piston chamber. It will also be seen that by forcing the piston against the wall of the chamber by excess of pressure from behind, instead of drawing it to the wall of the chamber by a crank or other rigid mechanical device, a substantially perfect contact must always ensue and continue, and that the piston is constantly fitted to the wall of the chamber as it wears, the very action of wearing tending to give it a better fit, while if a crank or rigid connection be employed there is no compensation for wear or opportunity for it.

Another advantage which arises from this form of construction and operation is that the meter is kept free from sediment, and the accidental lodging of foreign matter on the piston lobes or walls of the chamber cannot injure the meter or interfere with its practical working, as the lobe is pressed away by or rides over it, and it is then immediately washed off by the liquid.

It will also be observed that by making the wearing portions of the meter separate or detachable from the casing, as shown in Figs. 9 to 14, inclusive, the casing can be made of cast-iron, and the wearing parts of more expensive, durable, and non-corrosive material, thereby lessening the cost of construction, increasing the efficiency and life of the meter, and enabling repairs to be cheaply, economically, and readily made.

It will be observed that the reducing gearing and drum are contained in a recess within the piston, and that they are therefore within the piston-chamber, and that by so arranging them less space

is required than where they are placed without the piston-chamber, as is generally the case.

Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. In water meters, pumps, or motors, a piston-chamber having the measuring spaces or recesses described, each of which has a separate inlet-port and a separate outlet-port directly connected therewith, as specified, in combination with a piston having a lobe or projection entering each of said spaces or recesses, and adapted to be brought in contact with the walls of the chamber by the excess of pressure from behind, whereby the lobes are given the successive movements in their respective spaces or recesses indicated, all as set forth.

2. In a water meter, pump, or motor, a chamber having measuring recesses or spaces opening therefrom, in combination with a piston having a separate lobe or projection entering each of said recesses or spaces, and adapted to be brought in contact with the walls thereof, and to be held in contact therewith during the movement of the piston by the direct pressure exerted upon the piston, as specified, all substantially as set forth.

3. In water meters, pumps, or motors, the combination of a piston-chamber having measuring spaces or recesses opening therefrom, each of which has an inlet-port and an outlet-port, with a piston having a lobe or projection entering each space or recess adapted to control the exhaust-port thereof and to maintain a contact with the wall of the space or recess, which contact is maintained by the excess of direct pressure in the piston-chamber, as described, all substantially as set forth.

4. In a water meter, motor, or pump, the piston-chamber having measuring recesses or spaces forming a part thereof, a piston, F, having a projection or lobe entering each of said spaces or recesses, which projections or lobes are adapted to be brought successively into contact with the walls of said spaces or recesses, and to be moved therein, and the contact maintained during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, a register, and devices connecting the piston with the register, all substantially as and for the purposes set forth.

5. In a water meter, motor, or pump, the piston-chamber having measuring spaces or recesses forming a part thereof, a distributing-chamber having an inlet, a', the passages or inlet-ports E, connecting the distributing-chamber with the measuring spaces or recesses of the piston-chamber, a piston having a separate or distinct lobe or projection which enters each of said measuring spaces or recesses and is operated or moved and the contact maintained by the excess of pressure, as herein set forth, all substantially as and for the purposes described.

6. In a water meter, motor, or pump, the combination of the distributing-chamber a^2, its inlet a', the piston-chamber D, having
481 measuring recesses or spaces d, the uncontrolled ports or passages E, connecting the distributing-chamber a^2 with the recesses or spaces d, the outlet-ports E′, and escape passages connected

therewith, and the piston F, having the lobes or projections *f*, one for each of the measuring spaces or recesses *d*, and operated or moved therein to maintain contact during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, all substantially as described.

7. In a water meter, motor, or pump, the independent or separate base-section containing the inlet-passage a', the distributing-chamber a^2, and the outlet-passage a^3, with the independent or separate section B, containing the piston-chamber D, with the measuring recesses or spaces *d*, connected with the distributing-chamber and outlet-passage, as described, and the piston F, having a lobe or projection for each of said spaces or recesses, and the bolts for fastening the two sections of the meter together, all substantially as and for the purposes described.

8. The combination of the section A, having the distributing-chamber a^2, the section B, and the removable port-plate B^2, having the ports E.

9. In a meter, motor, or pump, the combination of the section A, having the distributing-chamber a^2, the section B, containing the measuring-chamber, the port-plate B^2, and the packing-ring B'.

10. In a water-meter as a means for communicating the motion of the piston to the register, the mechanism described, consisting of the stationary gear g^6, the revolving gears g^7 g^8, adapted to be revolved around the stationary gear by the piston, and the gear g^9 upon the connecting-spindle.

11. The combination of the piston F, the disk G, the drum or frame g^2, pivoted, as described, to be revolved, and the differential gears inclosed within said drum or case.

12. The combination, in a water-meter, of the piston-chamber D, the piston F, the reducing mechanism or gearing for transmitting the motion of the piston to the registering device contained in a recess in the piston, and the registering mechanism, all substantially as and for the purposes described.

13. In a water meter, motor, or pump, a piston-chamber having measuring spaces or recesses, and a loosely-fitted piston having lobes or projections extending into said spaces or recesses to form by contact with the walls thereof successive discharge-spaces, the said walls being shaped to provide the surface of the piston within the contacting lines of the discharge-spaces with less area than the remainder of the piston, subjected to the direct action of the pressure from behind, whereby the piston or valve may be loosely fitted in the piston-chamber, and by the excess of pressure caused by the difference in area is brought in contact with the walls of the measuring spaces or recesses, maintained in contact therewith, and rotated, all substantially as described.

JAMES A. TILDEN.

Witnesses:
F. F. RAYMOND, 2D.
FRED. B. DOLAN.

482 NAT. METER CO. *vs.* YONKERS.

COMPLAINANT'S EXHIBIT H I, TILDEN REISSUE. Oct. 13, 1888.

(2–175.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the reissue letters patent granted James A. Tilden, assignor by mesne assignments to the Hersey Meter Company, November 2, 1886, number 10778, for improvement in water meter with revolving pistons.

In testimony whereof I, Benton J. Hall, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 2d day of June, in the year of our Lord one thousand eight hundred and eighty-eight, and of the Independence of the United States the one hundred and twelfth.

Seal Patent Office, United States of America.

BENTON J. HALL,
Commissioner.

483 Dictated.

Thos. M. Clarke. F. F. Raymond, 2d.

29 PEMBERTON SQUARE, BOSTON, MASS., *Sept.* 28, 1886.

Commissioner of Patents, Washington, D. C.

SIR: We enclose herewith the application of James A. Tilden, of Hyde Park, Mass., for reissue of patent No. 324,503, dated August 18, 1885. With the application is an abstract of title, the statement required under rule 86, the assent of the Hersey Meter Company, the assignees, and the original patent, and check for $30 in payment of Government fees.

Very respectfully, CLARKE & RAYMOND.

[Endorsed:] U. S. Patent Office, Sept. 30, 1886. Received.

484 $30.

To the Commissioner of Patents, Washington, D. C.:

Your petitioner, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, hereby appoints Thos. Wm. Clarke and F. F. Raymond, 2d, of 29 Pemberton square, Boston, Mass., his attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith.

JAMES A. TILDEN.

29 Pemberton Sq., Boston, Mass., Sept. 29, 1886.

485 To the Commissioner of Patents:

Your petitioner, James A. Tilden, a citizen of the United States, residing at Hyde Park, in the county of Norfolk and State of Massachusetts, prays that he may be allowed to surrender the letters patent for an improvement in rotary fluid meters granted him, as assignor to Hersey Brothers, of Boston, Massachusetts, August 18, 1885, No. 324,503, whereof the Hersey Meter Company of Portland, Maine, a corporation duly organized under the laws of the State of Maine, on whose behalf and with whose assent this application is made, is now sole owner by assignment, and that letters patent may be reissued to the said Hersey Meter Company for the same invention upon the annexed amended specification.

With this petition is filed an abstract of title, duly certified, as required in such cases.

JAMES A. TILDEN.

The Hersey Meter Company, the assignee of the entire interest in the above-named letters patent, hereby assents to the accompanying application.

HERSEY METER COMPANY,
[L. S.] By FRANK C. HERSEY, *Treas.*

486 *Specification.*

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in explaining its nature.

It is well known that a fluid meter to be practically and commercially successful must be capable of measuring and registering the quantity of fluid which passes through it under all conditions, that it must not easily get out of repair, that its construction must be simple, and that its manufacture must be inexpensive.

Various meters have been made with some, if not all, of these requirements; but, so far as I am aware, there is not at present in the market any meter which combines all of these features, with certain necessary wearing qualities, to such an extent that it may be said to be a really commercially successful or practical meter, and while my invention may not be perfect in every respect, yet it has all the requisites of an efficient, desirable, and cheap meter.

487 The invention is embodied in a fluid meter comprising a stationary chamber, having measuring spaces or recesses opening therefrom, the ends of the chamber being closed by fixed parallel heads, whereby the weight and end pressure on the piston which moves therein are reduced; a piston of less diameter than that of said chamber accurately fitted between said heads and having lobes or projections equal in number to the chamber spaces, each

lobe moving in and conforming in shape to its space; an inlet port for the supply to each measuring space of fluid under pressure, and outlet ports at each end of the piston, extending from each measuring space to an escape passage, whereby the piston is balanced in its function as a fluid-actuated valve.

If the piston is placed centrally within the chamber, its irregular peripheral surface will be concentric to the opposed interior surface of the chamber, and the distance between said surfaces will be the radius of the extent of the piston's movement, which movement and its contact result, not from mechanical means, but from hydraulic action of the fluid in passing through the meter, during which time the piston is eccentric within the chamber.

The meter can hardly be called a "rotary" meter, be-
on its own axis, although it does revolve about the center of the case,
J. A. T. cause the piston does not rotate A and yet it is quite unlike in appearance any of the ordinary reciprocating-piston meters, but it combines, it may be said, portions of both systems in substantially this manner. The measuring chamber of the meter is divided or separated upon its outer edge into measuring spaces or recesses, all of which open into the central portion of the chamber, but which may or may not be of uniform size and shape.

488 Each of these spaces has its individual inlet and outlet ports. The part which I call the "piston" has radially extending portions or lobes, each of which enters its measuring space or recess and does not at any time leave its recess, and has a movement therein that causes it to be brought into contact with one side of its recess near the mouth and to advance along the side continuously until it reaches the other side of the recess, when it returns across the mouth of the recess or space to its original position. This movement of each lobe in each space or recess alternately exposes and closes the outlet ports, thereby preventing the flow of liquid from the chamber only after it has entered what may be termed the "measuring" and "discharging" spaces or recesses.

The piston performs a double duty. It not only acts to form measuring spaces and to discharge their contents, but the portions thereof which cover the outlet ports also act as the valves of the piston chamber, in that they serve alternately and in successive order to valvularly control or open and close the outlet ports; and, as it is essential that the piston should move in the piston chamber with as little friction as possible, I have arranged the outlet ports in the stationary or fixed heads or plates so that the piston is balanced as regards end pressure in the piston chamber between two opposed or equalizing pressures exerted against its ends or end surfaces.

To understand the working of the device it must be borne in mind that the fluid has free access to the chamber—that is, its inlet ports are never entirely closed; that because of the shape of the wall of the chamber and of the piston the piston is kept in

489 contact with the wall of the chamber at a number of what I call contact lines, which form the changing limits of measuring and discharging passages, spaces, or recesses. The number of

lines of contact depend, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary because a full head is maintained in the larger part of the chamber, and it is, of course, necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by fluid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes, in connection with the portions of the wall which constitute or form the spaces or recesses, also act to separate the outlet ports from the inlet ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact lines, one between the outer surface of the lobe and the wall of the recess and the other between the surface of the inward projection of the wall and the surface of the piston between the lobes. These lines of contact continually advance until the fluid has been expelled from each space or recess. While, however, this discharge from each space or recess is going on by the movement of the lobe the space or recess *is* filling behind the lobe. Of course, the number of spaces or recesses which are discharging simultaneously depend upon the entire number of spaces or recesses which the chamber contains, and there may be several recesses or spaces discharging and receiving at the same time. This advancing movement of the lobe in each space or recess does not continue beyond its individual space, but upon reaching the end of that space or
490 recess it returns across the mouth or entrance of its recess or space to its original position, while the piston, as a whole, rotating without [revolving]* on or about its axis, moves on a circular path.

The contact lines of the piston, in the operation of dividing the chamber into measuring spaces or recesses and discharging the same, are always upon the same side of the piston, and these contacting lines are brought successively into operation, not by rotation of the piston, but by the successive reverse movements of the lobes, so that the piston, while appearing like a rotating piston, is in principle like a reciprocating piston, in that each of its lobes or projections is caused to enter a measuring space or recess, advance therein, empty it, and return to its original position, to again advance in the said space or recess and empty. In making this movement the contact between each lobe and the wall is not maintained during the reverse movement of each lobe or projection.

The piston in other respects has more of the principle of a reciprocating piston than of a rotating piston, in that each lobe or projection operates as a separate or distinct piston or discharging device in connection with its respective space or recess, so that, the recess or space being filled with liquid, the lobe enters it and presses the liquid therefrom through the outlet ports. In other words, each lobe or projection does not act to displace the liquid from the spaces or recesses, like a plunger, but to discharge the liquid therefrom by

* Word enclosed in brackets erased in copy.

an advancing movement from one end of the chamber or recess to the other, like a piston.

491 In the drawings—

Figure 1 represents a side elevation of the machine. Fig. 2 is a plan view of a portion of the meter above the line $x\ x$ of Fig. 1, inverted, showing the piston and upper series of outlet ports. Fig. 3 is a view, principally in vertical central section, showing, especially, mechanism for connecting the piston with the registering train. Fig. 4 is a section upon the line $y\ y$ of Fig. 3, also showing the lower series of outlet ports and the inlet ports. Fig. 5 is a view, principally in vertical section, upon the lines $z\ z$ of Fig. 4, showing especially the relation of the outlet parts, meter walls, and spaces or recesses when discharging. Fig. 6 is a plan view of the packing piece between the base and main sections of the meter. Fig. 7 is a plan view of the base section, showing the receiving chamber and the inlet and outlet passages. Fig. 8 is a perspective view of the piston. Figs. 9 to 15, inclusive, illustrate special details of a modified form of construction. Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction. Fig. 19 is a diagram showing by calculation the differences in pressure which cause the action of the meter. Figs. 20 and 21 are sections of the reducing gears hereinafter described, and Fig. 22 is a view of the sleeve forming the support of the drum carrying the gears.

Preferably the casing of the meter comprises three principal parts or sections: first, the base section A; second, the body or main section B, and, third, the shell C, forming the chamber c containing the registering mechanism.

492 The base section is made somewhat larger in circumference than the main section, and the two parts are fastened together by bolts a, which pass through the flange b of the main section. The base section has the inlet passage a^1, which opens into the distributing chamber a^2 and the outlet passage a^3. The distributing chamber a^2 occupies almost the entire upper portion of the base, and its object is to provide means for the ready distribution of fluid simultaneously through the various inlet ports to the main chamber D.

Between the sections A B is a packing piece, B^1, which is shaped as shown in Fig. 6 and is provided with holes for [the]* J. A. T. bolt holes, the inlet ports, and outlet passage. Above this packing is a metal plate or head, B^2, which may be called a "port plate." It rests upon the packing B^1 and is held or fastened in place upon it and the upper surface of section A, surrounding the chamber a^2 and the central projection a^4, by the bolts a, the plate being within the main section B and its edge projecting into a recess formed in the under edge thereof. This port plate has the holes E, which form the inlet ports to the chamber D and connect the distributing chamber a^2 therewith. These ports E are arranged preferably to open into each space or recess d of the cham-

* Word enclosed in brackets erased in copy.

ber D at one side thereof. The port plate also has a central hole, which forms a portion of the outlet a^3 and the outlet ports E^1, which are recesses formed in the upper surface of the plate and arranged to extend from one side of each recess or space d inward upon converging lines. The chamber D has the measuring recesses or spaces d arranged about its outer edge, which open into the central portion, and the projections or portions of the wall of
493 the chamber which form spaces or recesses I have lettered d^1.

The piston F preferably is made of hard, vulcanized India rubber, gutta-percha, or other equivalent material and has the wings or lobes f, which extend radially therefrom.

The central hole f^1 of the piston forms a part of the outlet passage and is large enough to always permit the escape of fluid therefrom into the outlet a^3, regardless of the position of the piston.

In addition to the lower set of outlet ports, E^1, I have formed in the under surface of the head or upper plate, b^2, which forms the top of the main section B, another set of outlet ports, E^2 (shown in Figs. 2 & 5), J. A. T. They are of the same shape and connect the same parts of the spaces or recesses with the opening f^1 as the lower exhaust ports, E^1.

It will be seen that each measuring space or recess is connected with the outlet passage by two outlet ports E^1 E^2, formed by depressions or recesses in the plates or heads $[D^2]^*$ b^2 and J. A. T. arranged so that the fluid in the measuring spaces escapes between the port plates or heads and the ends of the piston. It will be seen further that if one set only of outlet ports were employed the pressure of the fluid upon one end of the piston would be less than that exerted against the other end, and the piston would be pressed against the head or plate having the outlet ports, and the resulting friction would interfere with the advantageous working of the piston. To obviate this friction I make use of opposed outlet ports arranged at opposite ends of the piston or in the opposite stationary heads of the fixed case, which results in bringing equal balancing pressures upon the piston ends, thus balancing and floating the piston endwise between two op-
494 posed fluid pressures of equal force.

There is also arranged in the hole f^1 a perforated disc, G (see Figs. 2 and 3), by which motion is communicated to the shaft which operates the train of gears comprising the registering mechanism. This disc carries at its center a stud, g, which projects downward from the drum g^1, which is pivoted at g^2 to the screw-sleeve g^3, which passes through the hole in the plate b^2 and is locked thereto by the nut g^4, which screws upon the thread g^5, and the movement of the piston causes the drum to be revolved upon the sleeve. It is necessary, however, as the chamber is of small capacity and as the motion of the piston is rapid, to reduce the motion of the piston very considerably, and it is desirable to do so in as simple a

* Letter and figure enclosed in brackets erased in copy.

manner and with as few parts as possible, in order that the construction may be cheap and as little weight of metal used as possible; and I employ for this purpose a train of four gears, one of which, g^6, is stationary, being secured to the end of the sleeve g^3. The gears g^7 g^8 are attached to the drum by the shaft [or pinion]* $g^{[9]}_{10}$*, to which they are fastened, and the gear g^7 meshes with
J. A. T. the gear g^6. The gear g^8 is arranged to mesh with the fourth gear, g^9, which is fastened to the spindle g^{10}, which communicates motion to the registering train. As the drum revolves about the sleeve g^2, it is obvious that if the gear g^7 has more or less teeth than the gear g^6 it will be caused to move each revolution of the drum a certain portion of a revolution, depending upon the difference in the number of teeth between the two gears. It is also obvious that if the gears g^8 g^9 have the same number of teeth as
the gear g^7 a movement of rotation will be communicated to
495 the shaft or spindle g^{10}.

If it is desired to still further reduce or change the rate of the rotation of the shaft g^{10}, then the gear g^8 may have more or less teeth than the gear g^7, as the case may be, as also may the gear g^9; and in the drawings I have represented the gear g^6 as provided with 10 teeth, the gear g^7 with 9 teeth, the gear g^8 with 8 teeth, and† A the gear g^9 with 9 teeth, so that upon every complete revolution of the drum the shaft g^{10} is moved one eighty-first of a revolution, and it therefore requires eighty-one revolutions of the drum to make one complete revolution of the shaft, the spindle or shaft g^{10} being used, of course, to operate any registering mechanism.

It will be seen by this construction of gearing that the drum g^1, carrying the gears g^7 g^8, revolves from left to right, and that the gear wheels g^7 g^8, being carried by the drum, are caused by the meshing of the gear g^7 with the stationary gear g^6 to turn from right to left, and that the meshing of the gear g^8 as it is turned upon its revolution about the gear g^9 causes the gear g^9 to be moved, as above specified, one eighty-first of a revolution for each revolution of the drum and the gears g^7 g^8 about it.

It will be observed that by making the mechanism for reducing the movement of the piston in compact form I am enabled to place it in the measuring chamber and within the hole formed in the piston, thereby economizing space.

In operation the liquid passes into the distribution chamber a^2 and through the inlet ports E into the chamber D, moving the piston
toward one side of the chamber and causing the formation of
496 measuring or discharge spaces by the contact of the various portions of the piston with the chamber wall. This position of the piston is well shown in Fig. 4, where there have been formed six divisions of the three spaces or recesses d by the contacting of the piston at the points 1, 2, 3, 4, 5, 6, and 7, and of these three recesses or spaces two, namely, the small spaces marked M and the

* Words and figure enclosed in brackets erased in copy.
† In pencil in copy.

space M^1, are connected by the discharge ports E^1 E^1 E^2 E^2 with the escape passage, while the space M^2 is about to be; but the fluid, upon being admitted to the chamber under pressure, not only immediately moves the piston to the position shown in Fig. 4, which is one of any number of positions which it might cause it to assume, and from such position it causes it to advance or move so that the lobes which are in contact with the wall of the chamber are caused to continue that contact until they have expelled all the fluid which is in the discharge spaces or recesses before them, when each lobe in succession will leave the surface and return upon an arc of a circle to a position where it again comes in contact with the surface of the wall of the chamber on the opposite side from that which it left, and again advances and expels the fluid from its recess or space.

It will be seen that each recess or space becomes in succession a discharge space or recess, and that as soon as the piston has moved sufficiently to uncover the inner end of its outlet ports it
J. A. T. begins to discharge through such ports into the escape passage[s b^3]* a^3, and that while a portion of each space or recess is discharging another portion is also receiving the liquid under pressure through the ports E.

To illustrate why, with the arrangement of the inlet and
497 outlet ports described, the piston is compelled to make the motion that it does, I have shown in Fig. 19 by diagrams the differences in pressure upon both sides of the piston and the extent of the surface which is subjected to the direct pressure of the entering fluid.

It is obvious that the chamber D, excepting the spaces which are discharging, is filled with fluid under pressure, and that the pressure for moving the pistons is that which enters each space or recess which is being discharged and behind the respective discharging lobe. For instance, referring to Fig. 4, the piston is receiving motion from the fluid which enters the spaces through the ports marked N N N, but from no other. It is not necessary that the main chamber and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses from three upward, and that they may be of any size and of different sizes for the same piston, the only difference to be observed being that the piston and chamber wall must be so shaped as to provide the contact lines in the surface of the piston or chamber wall whereby the formation of measuring chambers is effected.

In Fig. 16 I have illustrated a piston having three lobes in a chamber having three measuring and discharge spaces or recesses. In Fig. 17 I have shown a piston with two large lobes and two small ones and a chamber with corresponding recesses or spaces. In Fig. 18 I have represented the piston as having square lobes and the chamber with spaces which substantially follow the shape of the lobes, the only variation being that they are rounded at the corners.

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† Letters and figure enclosed in brackets erased in copy.

498 It will be obvious from what I have stated that the meter is very simple in construction; that it has but very few parts, which require but little machine-work and are easily fitted and put together, and it is also apparent that a substantially perfect registration of the liquid which passes through the meter is obtained, as it all is obliged to pass into the measuring spaces which are successively emptied. It will be seen further that this measuring of the liquid takes place very rapidly and with the minimum of friction of the wearing parts, and that the construction of the piston and chamber is such that sediment cannot interfere with the proper working of the invention, and that wear up to a certain extent improves the efficiency of the meter, in that it causes the contacting surfaces of the piston and chamber to fit themselves as they wear.

To still further cheapen the manufacture I show in Figs. 9 to 15, inclusive, a construction which enables me to use instead of the comparatively expensive casing of composition an iron casing. This I accomplish by making the base section entirely of iron, employing two composition port plates O O^1, the plate O being like that described and the plate O^1 having simply the exhaust passages E^2. The piston is made of hard rubber, gutta-percha, or other like non-corrosive material, and the wall O^2 (see Fig. 14) of the chamber D is formed of a ring or sleeve of gutta-percha, hard India rubber, or even of composition, which is fitted into the iron shell or casing of the main section. This non-corrosive, movable wall of the chamber is fastened to the casing by means of a key, *o*, which enters a groove in the ring and a corresponding one in the inner surface of the iron shell or in any other suitable way. A view in perspective of the movable wall is shown in Fig. 14.

499 It will be seen that by this construction not only can an iron shell be employed, but that the principal wearing parts, namely, the port plates, the piston, and the wall of the chamber, may be easily removed and others substituted therefor. The port plates are also held in place by suitable keys or in any other desirable way, and it will be observed that they extend upon the two end surfaces of the removable wall. (See Fig. 9.)

While the invention as shown in the drawings represents a piston which while not rotating moves in a circular path, yet by changing the forms of the piston lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, elliptical, or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston the principle of its action is not changed, as the lobe or portion of the piston which penetrates the measuring space will have a continuous movement in said space, whether its path be circular, square, rectangular, elliptical, or of any other shape.

In this construction the piston in motion is held in changing lines of contact with the internal irregular surface of the fixed case by

hydraulic action, as illustrated by the diagram Fig. 19 and the calculation there noted, so that while the piston is controlled in its movement by contact with the fixed case it is free to depart from such contact, being held thereto only by fluid pressure and not by mechanical means, such as cranks, links, abutments, etc., and
500 so can move over obstructions interposing between the irregular peripheral surface of the piston and the opposed surface of the fixed case without causing the piston to jam and cease motion, and without risk of breakage or of strain of any part.

Of course, the invention can be utilized as a pump or motor if desired.

501 Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. A fluid meter having a stationary piston chamber with measuring recesses opening therefrom, each separately provided with inlet and outlet ports, and having a movable piston fitted as described in said chamber, with lobes conforming to the chamber recesses, each lobe entering and moving in but one recess and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, and having parallel stationary heads or plates, whereby end pressure on the piston is relieved and weight of the moving parts is reduced, substantially as set forth.

2. A fluid meter having a stationary piston chamber with measuring recesses opening therefrom, each separately provided with inlet and outlet ports, and having a movable piston fitted as described in said chamber, with lobes conforming to the chamber recesses, each lobe entering and moving in but one recess and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, and having the opposed arrangement of the ports, whereby balanced valvular action is effected, substantially as set forth.

3. A fluid meter having a stationary piston chamber with measuring recesses opening therefrom, each separately provided with inlet and outlet ports; a movable piston fitted as described in said chamber, with lobes conforming to the chamber recesses, each lobe entering and moving in but one recess, and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified; parallel stationary heads or plates, whereby the
502 weight of the piston is reduced and end pressure thereon is relieved, and an opposed arrangement of the ports, whereby balanced valvular action is effected, substantially as described.

4. In a fluid meter, the piston chamber having measuring recesses or spaces forming a part thereof, a piston, F, having a projection or lobe entering each of said spaces or recesses, which projections or lobes are adapted to be brought successively into contact with the walls of said spaces or recesses and to be moved therein and the contact maintained during the discharge of the liquid from each space or recess by the direct pressure in the piston chamber, as specified, a register and devices connecting the piston with the register, all substantially as and for the purposes set forth.

5. In a fluid meter, the piston chamber having measuring spaces

or recesses forming a part thereof, the stationary port plate B^2, a distributing chamber having an inlet, a^1, the passages or inlet ports E in the said stationary port plate B^2 connecting the distributing chamber with the measuring spaces or recesses of the piston chamber, and* A a piston having a separate or distinct lobe or projection which enters each of said measuring spaces or recesses and is operated or moved and its contact maintained by the excess of pressure, as herein set forth, all substantially as and for the purposes described.

6. In a fluid meter, the combination of the distributing chamber a^2, its inlet a^1, the piston chamber D, having measuring recesses or spaces d, the uncontrolled ports or passages E, connecting the distributing chamber a^2 with the recesses or spaces d, the outlet
503 ports E^1 E^2, and escape passage connected therewith and the piston F, having the lobes or projections f, one for each of the measuring spaces or recesses d, and operated or moved therein to maintain contact during the discharge of the liquid from each space or recess by the direct pressure in the piston chamber, as specified, all substantially as described.

7. In a fluid meter, the independent or separate base section, containing the inlet passage a^1, the distributing chamber a^2, and the outlet passage a^3, with the independent or separate section B, containing the piston chamber D, having the measuring recesses or spaces d connected with the distributing chamber and outlet passage, as described, and the piston F, having a lobe or projection for each of said spaces or recesses and the bolts for fastening the two sections of the meter together, all substantially as and for the purposes described.

8. The combination of the section A, having the distributing chamber a^2, the section B, and the removable port plate B^2, having the inlet ports E and outlet ports E^1.

9. In a meter, the combination of the section A, having the distributing chamber a^2, the section B, containing the measuring chamber, the port plate B^2, and the packing ring B^1.

10. In a fluid meter, as a means for communicating the motion of the piston to the register, the mechanism described, consisting of the stationary gear g^6, the revolving gears g^7 g^8, adapted to be revolved around the stationary gear by the piston, and the gear g^9 upon the connecting spindle.

504 11. The combination of the piston F, the disk G, the drum or frame g^2, pivoted, as described, to be revolved, and the differential gears inclosed within said drum or case.

12. The combination, in a fluid meter, of the piston chamber D, the piston F, the reducing mechanism or gearing for transmitting the motion of the piston to the registering device contained in a recess in the piston, and the registering mechanism, all substantially as and for the purposes described.

13. A fluid meter having a piston chamber with measuring re-

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*In pencil in copy.

cesses opening therefrom, each separately provided with inlet and outlet ports, and having a piston fitted and moving as and for the purpose described, with lobes conforming to the chamber recesses and serving alternately and in successive order to valvularly control or open and close the outlets formed in the heads and piston.

JAMES A. TILDEN.

Witnesses:
F. F. RAYMOND.
FRED. B. DOLAN.

505 COMMONWEALTH OF MASSACHUSETTS, *Suffolk*, } *ss:*

James A. Tilden, the above-named petitioner, being duly sworn, deposes and says that he verily believes that his aforesaid letters patent are inoperative by reason of a defective specification and are invalid by reason of his claiming as his own invention more than he had a right to claim as new; that the error arose by inadvertence, accident, and mistake and without any fraudulent or deceptive intent; that the Hersey Meter Company of Portland, Maine, a corporation duly organized under the laws of the State of Maine, is the sole owner of said letters patent, and that this application is made on the behalf and with the consent of said Hersey Meter Company; that he verily believes himself to be the first and original inventor of the improvements set forth in the claim in this amended specification and does not believe that the same was ever before known or used.

That the specification is defective, in that it has not sufficiently distinguished the invention from what was set forth in letters patent of Great Britain to Elijah Galloway, No. 11485, dated December 14, 1846; that he has claimed therein more than he had a right to claim as new, in that he has defined his invention in such terms as to embrace such a structure as was described and shown in the said British patent to Galloway, in which there is but one set of ports and in which the single port plate is attached to the piston and moves with it.

That the said error arose because the said Galloway patent was not known to the applicant while his application was pend-
506 ing in the Patent Office and was not cited as a reference by the Patent Office examiner having the application in charge; that it did not come to the notice of this applicant until recently; that his said invention has not been in public use or on sale for more than a year and a half prior to the date of this reissue application, and that his said invention has not up to this time been practiced or employed by any one excepting the lawful owners of said patent and by those who have derived authority from them.

JAMES A. TILDEN.

Subscribed and sworn to before me this 29th day of September, 1886.

[L. S.] F. F. RAYMOND,
Notary Public.

[Endorsed:] Reissue. Serial No., 215,027. Paper No. 1/2. Application. Filed Sep. 30, 1886. United States Patent Office, a. Sep. 30, 1886, m., received.

507 No. 324,503.

(2–155.)

THE UNITED STATES OF AMERICA.

To all to whom these presents shall come:

Whereas James A. Tilden, of Hyde Park, Massachusetts, has presented to the Commissioner of Patents a petition praying for the grant of letters patent for an alleged new and useful improvement in rotary fluid meters, he having assigned his right, title, and interest in said improvement to Hersey Brothers, of Boston, Massachusetts, a description of which invention is contained in the specification of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of law in such cases made and provided; and

Whereas, upon due examination made, the said claimant is adjudged to be justly entitled to a patent under the law:

Now, therefore, these letters patent are to grant unto the said Hersey Brothers, their heirs or assigns, for the term of seventeen years from the eighteenth day of August, one thousand eight hundred and eighty-five, the exclusive right to make, use, and vend the said invention throughout the United States and the territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the city of Washington, this eighteenth day of August, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States of America the one hundred and tenth.

Seal Patent Office, United States of America.

H. L. MULDRON,
Acting Secretary of the Interior.

Countersigned:
M. V. MONTGOMERY,
Commissioner of Patents.

[Endorsed:] Serial No., 215,027. Paper No. 1. Original patent. Filed Sep. 30, 1886. United States Patent Office, a. Sep. 30, 1886, m., received.

516 UNITED STATES PATENT OFFICE.

JAMES A. TILDEN, of Hyde Park, assignor to Hersey Brothers, of Boston, Massachusetts.

Rotary Fluid-Meter.

Specification forming part of Letters Patent No. 324,503, dated August 18, 1885. Application filed December 22, 1884. (Model.)

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid-meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification in explaining its nature.

It is well known that a fluid-meter to be commercially successful must be capable of perfectly measuring or indicating the quantity of fluid which passes through it, regardless of the size of the stream, its speed, head, or any other condition, that it must not easily get out of repair, that its construction must be simple, and its manufacture inexpensive, and various meters have been made with some if not all of these conditions, but, so far as I am aware, there is not at present in the market any meter which combines all of these features with certain necessary wearing qualities to such an extent that it may be said to be a really commercially successful or practical meter; and while my invention may not be perfect in every respect, yet it has all the requisites of an efficient, desirable, and cheap meter.

The principle upon which the meter is constructed is so simple that but very few parts or pieces are necessary and very little machine-work required in fitting them, and these can be placed in such very small compass that the weight of metal necessary for the casing is very small.

The invention comprises, broadly speaking, a chamber having inlet and exhaust ports, and a piston for opening and closing the exhaust-ports. The meter can hardly be called a "rotary" meter, because the piston does not rotate, and yet it is quite unlike in appearance any of the ordinary reciprocating-piston meters; but it combines, it may be said, portions of both systems in substantially this manner. The measuring-chamber of the meter is divided or separated upon its outer edge into measuring spaces or recesses, all of which open into the central portion of the chamber, but which may or may not be of uniform size and shape. Each of these spaces has its individual inlet and exhaust ports. The part which I call the "piston" has a radially-extending portion or lobe, which enters each measuring space or recess and does not at any time leave it, and has a movement therein that causes it to be brought into contact with one side of each recess near the mouth and to advance

(Model.) 8 Sheets—Sheet 1.

J. A. TILDEN.

ROTARY FLUID METER.

No. 324,503. Patented Aug. 18, 1885.

No. 192.
Natl Meter Co.
v.
Bd. Water
Comrs
} p. 508.

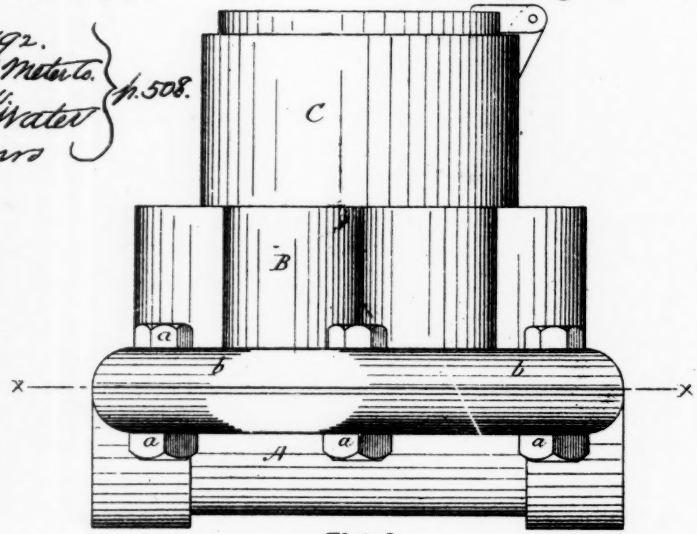
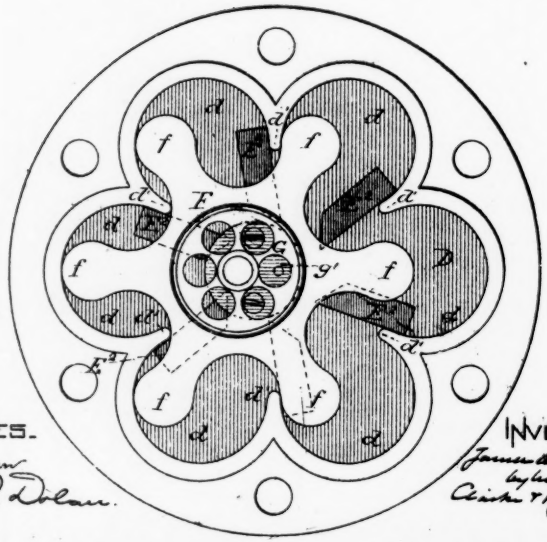


Fig. 1.

Fig. 2.



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ROTARY FLUID METER.

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Fig. 20.

Fig. 21.

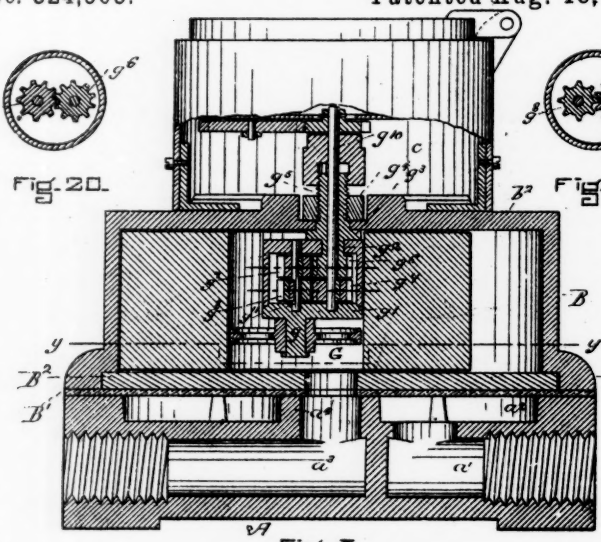

Fig. 3.

No. 192.
Natl Meter Co.
v.
Pd. Water Comm.
p. 509.

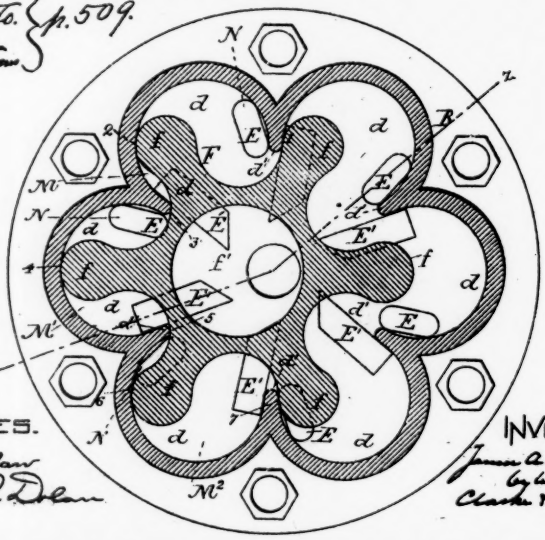

Fig. 4.

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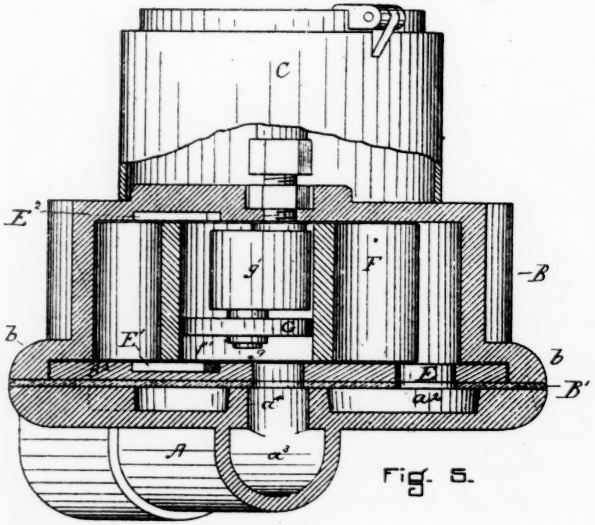
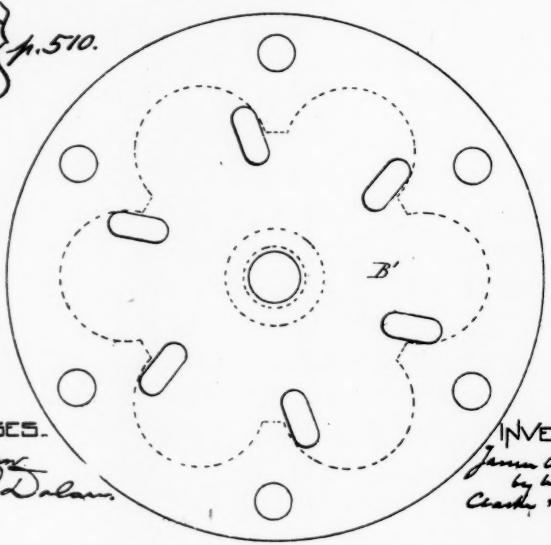


Fig. 5.

No 192
Natl Meter Co.
v.
Bd. Water
Comrs.
p. 510.

Fig. 6.



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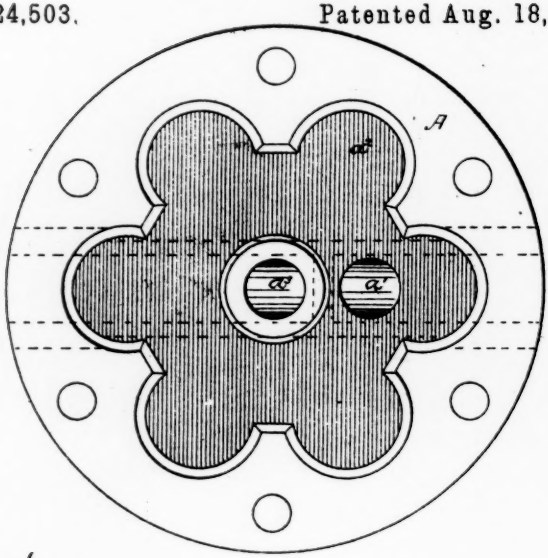

Fig. 7.

No. 192.
Natl Meter Co.
v.
Bd Water Comrs
p. 511.

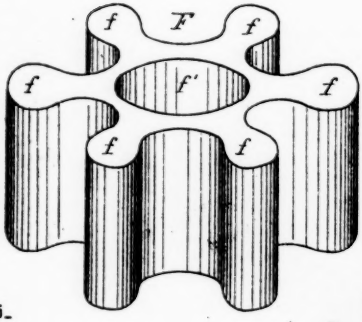

Fig. 8.

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Natl Meter Co.
v.
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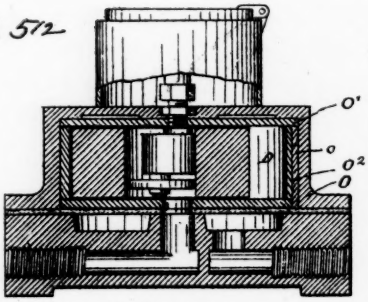

Fig. 9.

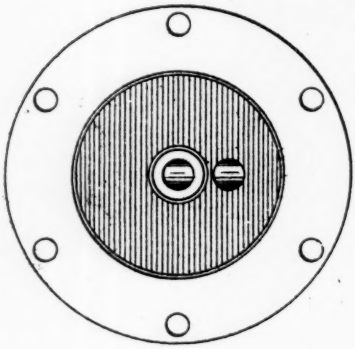

Fig. 10.

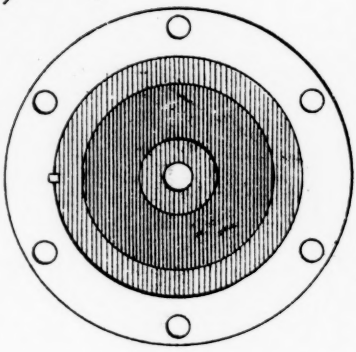

Fig. 11.

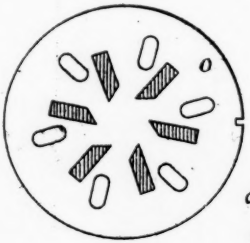

Fig. 12.

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Natl Meter Co.
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Red Water Comp
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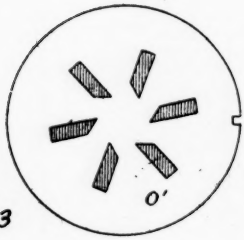

Fig. 13.

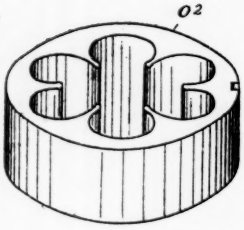

Fig. 14.

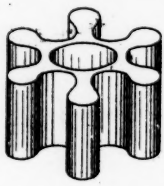

Fig. 15.

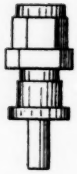

Fig. 22.

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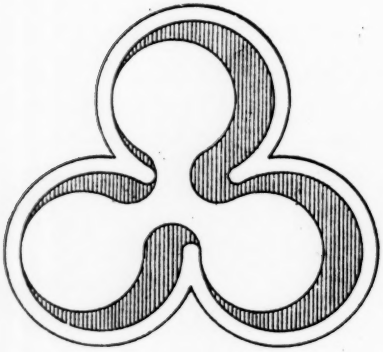

Fig. 16.

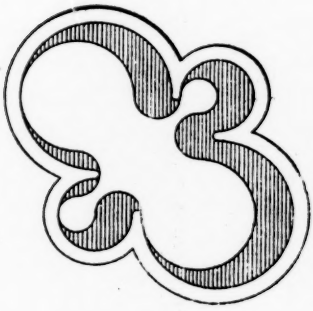

Fig. 17.

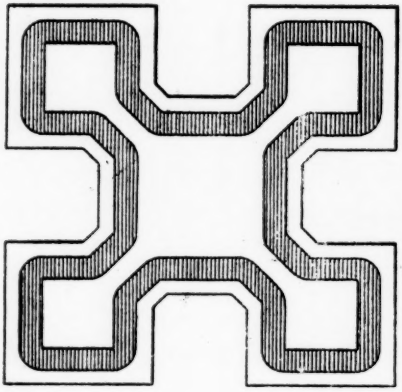

Fig. 18.

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Natl Meter Co.
v.
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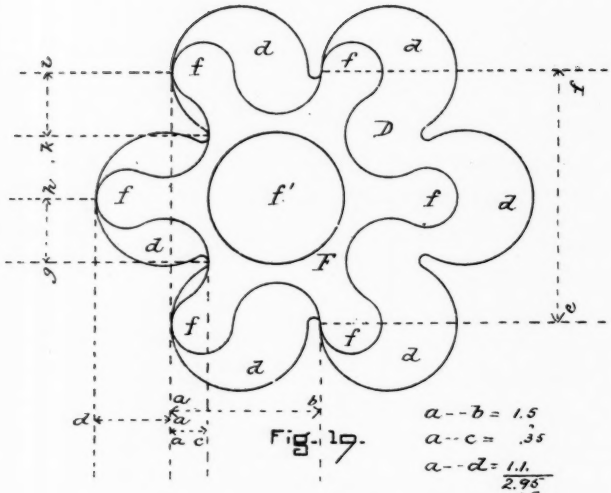

Fig. 19.

a--b = 1.5
a--c = .35
a--d = 1.1.
2.95
1.5
Rotative effect 4.425 sq. in.

e--f = 2.6 x 1.5 = 3.90
g--h = .65
k--l = .65
1.30 x 1.5 = 1.95
Excess pressure 1.95 sq. in.

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along the side continuously until it reaches the other side of the recess, when it returns across the mouth of the recess or space to its original position. This movement of each lobe in each space or recess alternately exposes and closes the exhaust ports, thereby preventing the flow of liquid from the chamber only after it has entered what may be termed the "measuring" and "discharging" spaces or recesses. The sides of the chamber and the sides of the piston should be parallel when the piston is centrally located in the chamber.

To understand the working of the device, it must be borne in mind that the liquid has free access to the chamber—that is, its inlet-ports are never entirely closed—that because of the shape of the wall of the chamber and of the piston, the piston is kept in contact with the wall of the chamber at a number of what I call "contact" points or lines, which form in the measuring and discharging passages spaces or recesses. The number of lines of contact depend, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary, because a full head is maintained in the larger part of the chamber, and it is of course necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by liquid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes in connection with the portions of the wall which constitute or form the spaces or recesses also act to separate the exhaust-ports from the inlet-ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact-lines, one between the outer surface of the lobe and the wall of the recess and the other between the surface of the inward projection of the wall and the surface of the piston between the lobes. These lines of con-
517 tact continually advance until the water has been expelled from each space or recess. While, however, this discharge from each space or recess is going on by the movement of the lobe, the space or recess is filling behind the lobe. Of course the number of spaces or recesses which are discharging simultaneously depend upon the entire number of spaces or recesses which the chamber contains, and there may be several recesses or spaces discharging and receiving at the same time. This advancing movement of the lobe in each space or recess does not continue beyond its individual space, but upon reaching the end of that space or recess it returns across the mouth or entrance of its recess or space to its original position, while the piston as a whole, without revolving, moves on a circular path.

In the drawings—

(Here follow diagrams marked pp. 508, 509, 510, 511, 512, 513, 514, and 515.)

Figure 1 represents a side elevation of the machine. Fig. 2 is a plan view of a portion of the meter above the line *x x* of Fig. 1, inverted, showing the piston and upper series of ex-

haust-ports. Fig. 3 is a view, principally in vertical central section, showing, especially, the mechanism for connecting the piston with the registering-train. Fig. 4 is a section upon the line *y y* of Fig. 3, also showing the lower series of exhaust-ports and the inlet-ports. Fig. 5 is a view, principally in vertical section, upon the lines *z z* of Fig. 4, showing, especially, the relation of the exhaust-ports, meter-walls, and spaces or recesses when discharging. Fig. 6 is a plan view of the packing-piece between the base and main sections of the meter. Fig. 7 is a plan view of the base-section, showing the receiving-chamber and the inlet and outlet passages. Fig. 8 is a perspective view of the piston. Figs. 9 to 15, inclusive, illustrate special details of a modified form of construction. Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction. Fig. 19 is a diagram showing by calculation the differences in pressure which cause the action of the meter. Figs. 20 and 21 are sections of the reducing-gears hereinafter described, and Fig. 22 is a view of the sleeve forming the support of the drum carrying the gears.

Preferably, the casing of the meter comprises three principal parts or sections—first, the base-section A; second, the body or main section B, and, third, the shell C, forming the chamber *c*, containing the registering mechanism.

The base-section is made somewhat larger in circumference than the main section, and the two parts are fastened together by bolts *a*, which pass through the flange *b* of the main section. The base-section has the inlet-passage *a'*, which opens into the distributing-chamber a^2 and the outlet-passage a^3. The distributing-chamber a^2 occupies almost the entire upper portion of the base, and its object is to provide means for the ready distribution of fluid simultaneously through the various inlet-ports to the main chamber D.

Between the sections A B is a packing-ring, B', which is shaped as shown in Fig. 6, and is provided with holes for the bolt-holes, the inlet-ports, and outlet-passage. Above this packing-ring is a metal plate, B^2, which may be called a "port-plate." It rests upon the packing-ring B', and is held or fastened in place upon it and the upper surface of section A, surrounding the chamber a^2 and the central projection, a^4, by the bolts *a*, the plate being within the main section B and its edge projecting into a recess formed in the under edge thereof. This port-plate has the holes E, which form the inlet-ports to the chamber D and connect the distributing-chamber a^2 therewith. These ports E are arranged, preferably, to open into each space or recess *d* of the chamber D at one side thereof. The port-plate also has a central hole, which forms a portion of the outlet a^3 and the escape or exhaust ports E', which are recesses formed in the upper surface of the plate, and arranged to extend from one side of each recess or space *d* inward upon converging lines. The chamber D has the measuring recesses or spaces *d* arranged about its outer edge, which open into the central portion, and the projections or portions of the wall of the chamber which form spaces or recesses I have lettered *d'*. The piston F preferably is made of hard

vulcanized india-rubber, gutta-percha, or other equivalent material, and has the wings or lobes *f*, which extend radially therefrom, and the central hole, *f'*.

For the best working of the device it is desirable, but not essential, that the surface of the piston, when the same is centrally located in the chamber D, shall be parallel with the surface of the chamber, so that as the surface of the chamber is made up of alternating recesses and projections, so the surface of the pistons is made up of alternating lobes and recesses. The central hole, *f'*, of the piston forms a part of the exhaust or outlet passage, and is large enough to always permit the escape of fluid therefrom into the outlet a^3, regardless of the position of the piston.

In addition to the lower set of exhaust-ports, E'. I have formed in the under surface of the upper plate, b^2, which forms the top of the main section B, another set of exhaust-ports, E^2. (Shown in Fig. 2.) They are of the same shape and connect the same parts of the spaces or recesses with the opening *f'* as the lower exhaust-ports, E'. There is also arranged in the hole *f'* a perforated disk, G, (see Figs. 2 and 3,) by which motion is communicated to the shaft which operates the train of gears comprising the registering mechanism. This disk carries at its center a stud, *g*, which projects downward from the drum *g'*, which is pivoted at g^2 to the screw-sleeve g^3, which passes through the hole in the plate b^2, and is locked thereto by the nut g^4, which screws upon the thread g^5, and the movement of the piston causes the drum to be revolved upon the
518 sleeve—that is, the drum and stud form substantially a crank.

It is necessary, however, as the chamber is of small capacity and as the motion of the piston is rapid, to reduce the motion of the piston very considerably, and it is desirable to do so in as simple a manner and with as few parts as possible, in order that the construction may be cheap and as little weight of metal used as possible; and I employ for this purpose a train of four gears, one of which, g^6, is stationary, being secured to the end of the sleeve g^3. The gears g^7 g^8 are attached to the drum by the shaft or pinion g^9, to which they are keyed, and the gear g^7 meshes with the gear g^6. The gear g^8 is arranged to mesh with the fourth gear, g^9, which is keyed or fastened to the spindle g^{10}, which communicates motion to the registering-train. As the drum revolves about the sleeve g^2, it is obvious that if the gear g^7 has more or less teeth than the gear g^6 it will be caused to move each revolution of the drum a certain portion of a revolution depending upon the difference in the number of teeth between the two gears. It is also obvious that if the gears g^8 g^9 have the same number of teeth as the gear g^7, a movement of rotation will be communicated to the shafts or spindle g^{10}. If it is desired to still further reduce or change the rate of the rotation of the shaft g^{10}, then the gear g^8 may have more or less teeth than the gear g^7, as the case may be, as also may the gear g^9; and in the drawings I have represented the gear g^6 as provided with ten teeth, the gear g^7 with nine teeth, the gear g^8 with eight teeth, the gear g^9 with nine teeth, so that upon every complete revolution of the drum the shaft g^{10} is moved one eighty-first of a revolution, and it there-

fore requires eighty revolutions of the drum to make one complete revolution of the shaft, the spindle or shaft g^{10} being used, of course, to operate any registering mechanism.

It will be seen by this construction of gearing that the drum g', carrying the gears g^7 g^8, revolves from left to right, and that the gear-wheels g^7 g^8, being carried by the drum, are caused by the meshing of the gear g^7 with the stationary gear g^6 to turn from right to left, and that the meshing of the gear g^8, as it is turned upon its revolution about the gear g^9, causes the gear g^9 to be moved, as above specified, one eighty-first of a revolution for each revolution of the drum and the gears g^7 g^8 about it.

In operation the liquid passes into the distribution-chamber a^2 and through the inlet-ports E into the chamber D, moving the piston toward one side of the chamber and causing the formation of measuring or discharge spaces by the contact of the various portions of the piston with the chamber-wall. This position of the piston is well shown in Fig. 4, where there have been formed six divisions of the three spaces or recesses d by the contacting of the piston at the points 1, 2, 3, 4, 5, 6, and 7, and of these three recesses or spaces, two—namely, the small spaces marked M and the space M′—are connected by the discharge-ports E′ E^2 with the escape-passage, while the space M^2 is about to be; but the fluid, upon being admitted to the chamber under pressure, not only immediately moves the piston to the position shown in Fig. 4, which is one of any number of positions which it might cause it to assume, and from such position it causes it to advance or move, so that the lobes which are in contact with the wall of the chamber are caused to continue that contact until they have expelled all the fluid which is in the discharge spaces or recesses before them, when each lobe in succession will leave the surface and return upon an arc of a circle to a position where it again comes in contact with the surface of the wall of the chamber on the opposite side from that which it left, and again advances and expels the fluid from its recess or space.

It will be seen that each recess or space becomes in succession a discharge space or recess, and that as soon as the piston has moved sufficiently to uncover the inner end of its escape-ports it begins to discharge through such ports into the escape-passages b^3 a^3, and that while a portion of each space or recess is discharging another portion is also receiving the liquid under pressure through the ports E.

To illustrate why with the arrangement of the inlet and exhaust-ports described the piston is compelled to make the motion that it does, I have shown in Fig. 19 by diagrams the differences in pressure upon both sides of the piston and the extent of the surface which is subjected to the direct pressure of the entering fluid.

It is obvious that the chamber D, excepting the spaces which are discharging, is filled with fluid under pressure, and that the pressure for moving the pistons is that which enters each space or recess which is being discharged, and behind the respective discharging lobe-. For instance, referring to Fig. 4, the piston is receiving motion from the fluid which enters the spaces through the ports marked N N N, but from no other. It is not necessary that the main chamber

and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses, from three upward, and that they may be of any size and of different sizes for the same piston, the only difference to be observed being that the piston and chamber-wall must be so shaped as to provide the contact-lines in the surface of the piston or chamber-wall, whereby the formation of measuring-chambers is effected.

In Fig. 16 I have illustrated a piston having three lobes in a chamber having three measuring and discharge spaces or recesses. In Fig. 17 I have shown a piston with two large lobes and two small ones, and a chamber with corresponding recesses or spaces. In Fig. 18 I have represented the piston as having square lobes, and the chamber with spaces which substantially follow the shape of
519 the lobes, the only variation being that they are rounded at the corners.

It will be obvious from what I have stated that the meter is very simple in construction, that it has but very few parts, which require but little machine-work and are easily fitted and put together, and it is also apparent that a substantially-perfect registration of the liquid which passes through the meter is obtained, as it all is obliged to pass into the measuring-spaces, which are successively emptied. It will be seen, further, that this measuring of the liquid takes place very rapidly, and with comparatively very little friction of the wearing parts, and that the construction of the piston and chamber is such that sediment cannot interfere with the proper working of the invention, and that wear, up to a certain extent, improves the efficiency of the meter in that it causes the contacting surfaces of the piston and chamber to fit themselves as they wear.

To still further cheapen the manufacture I show in Figs. 9 to 15, inclusive, a construction which enables me to use, instead of the comparatively expensive casing of composition, an iron casing. This I accomplish by making the base-section entirely of iron, employing two composition port-plates, O O′, the plate O being like that described, and the plate O′ having simply the exhaust-passages E^2. The piston is made of hard rubber, gutta-percha, or other like non-corrosive material, and the wall O^2 (see Fig. 14) of the chamber D is formed of a ring or sleeve of gutta-percha, hard india-rubber, or even of composition, which is fitted into the iron shell or casing of the main section. This non-corrosive movable wall of the chamber is fastened to the casing by means of a key, *o*, which enters a groove in the ring and a corresponding one in the inner surface of the iron shell, or in any other suitable way. A view in perspective of the movable wall is shown in Fig. 14.

It will be seen that by this construction not only can an iron shell be employed, but that the principal wearing parts—namely, the port-plates, the piston, and the wall of the chamber—may be easily removed and others substituted therefor. The port-plates are also held in place by suitable keys or in any other desirable way, and it will be observed that they extend upon the two end surfaces of the removable wall. (See Fig. 9.)

Of course the invention can be utilized as a pump or motor, if desired.

It will be observed that by making the mechanism for reducing the movement of the piston in compact form, I am enabled to place it in the measuring-chamber and within the hole formed in the piston, thereby economizing space.

As the gears are inclosed in a drum or casing, no sediment can reach them to disturb their easy action.

While the invention as shown in the drawings represents a piston which, while not rotating moves in a circular path, yet by changing the forms of the piston-lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, elliptical, or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston the principle of its action is not changed, as the lobe or portion of the piston which penetrates the measuring-space will have a continuous movement in said space, whether its path be circular, square, rectangular, elliptical, or of any other shape.

It will be seen that the contacting points or lines of the piston or valve are, in the operation of dividing the chamber into measuring-spaces or recesses and discharging the same; always upon the one side of the piston, and that these contacting points are brought successively into operation, not by the rotation of the piston or valve, but by their successive reverse movements, so that the piston or valve, while appearing more like a rotating piston or valve, is in principle more like a reciprocating piston or valve, in that each of its lobes or projections is caused to enter a measuring space or recess, advance therein, empty it, and return to its original position to again advance in the said space or recess and empty. In making this movement the contact between each lobe and the wall is not maintained during the reverse movement of each lobe or projection.

It will further be seen that by this construction the contacting points always being upon one side of the piston, and the piston being held against the wall of the chamber by the water-pressure behind, or that not included within the contact-lines, it is very loosely fitted within the chamber, so loosely, indeed, that it is free to be moved back and forward therein the depth of a measuring space or chamber, and is dependent upon the water-pressure for maintaining the proper contact with the walls of the chamber and for its operation.

It will further be seen that from this principle of construction there can be very little friction between the running parts, and that sediment or foreign substances cannot interfere with the fine and regular working of the device.

It will also be noticed that the piston in other respects has more of the principle of a reciprocating piston than of a rotating piston, in that each lobe or projection operates as a separate or distinct piston or discharging device in connection with its respective space or recess, so that the recess or space being filled with liquid, the lobe

enters it and presses the liquid therefrom through the exhaust-port. In other words, each lobe or projection does not act to displace the liquid from the spaces or recesses, but to discharge the liquid therefrom by an advancing movement from one end of the chamber or recess to the other.

It will be seen that the piston is made to fit the piston-chamber loosely, and that the necessary contact between its contacting-surfaces and the wall of the chamber is obtained and maintained by so arranging the contacting-points and the admission of pressure to the chamber that there shall always be a sufficient area of the piston exposed to the direct pressure to cause it to overcome all resistance and to keep it in contact with the wall of the chamber while it is being moved.

I have shown in Fig. 19 a diagram which illustrates this feature of construction, giving *for* the form of piston and piston-chamber therein shown, the area of the piston upon which the direct pressure is exerted, and the area upon which there is a resisting force; and it will — seen from the calculations noted upon said drawing that there is always an excess of pressure to maintain the piston in operation in working position. The said diagram and calculations also show how the rotative effect is obtained.

In order that this result may be obtained it is not only necessary that the piston be loosely fitted, but that its surface should be substantially parallel with the surface of the piston chamber. It will also be seen that by forcing the piston against the wall of the chamber by excess of pressure from behind, instead of drawing it to the wall of the chamber by a crank or other rigid mechanical device, a substantially perfect contact must always ensue and continue, and that the piston is constantly fitted to the wall of the chamber as it wears, the very action of wearing tending to give it a better fit, while if a crank or rigid connection be employed there is no compensation for wear or opportunity for it.

Another advantage which arises from this form of construction and operation is that the meter is kept free from sediment, and the accidental lodging of foreign matter on the piston lobes or walls of the chamber cannot injure the meter or interfere with its practical working, as the lobe is pressed away by or rides over it, and it is then immediately washed off by the liquid.

It will also be observed that by making the wearing portions of the meter separate or detachable from the casing, as shown in Figs. 9 to 14, inclusive, the casing can be made of cast-iron, and the wearing parts of more expensive, durable, and non-corrosive material, thereby lessening the cost of construction, increasing the efficiency and life of the meter, and enabling repairs to be cheaply, economically, and readily made.

It will be observed that the reducing gearing and drum are contained in a recess within the piston, and that they are therefore within the piston-chamber, and that by so arranging them less space is required than where they are placed without the piston-chamber, as is generally the case.

Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. In water meters, pumps, or motors, a piston-chamber having the measuring spaces or recesses described, each of which has a separate inlet-port and a separate outlet-port directly connected therewith, as specified, in combination with a piston having a lobe or projection entering each of said spaces or recesses, and adapted to be brought in contact with the walls of the chamber by the excess of pressure from behind, whereby the lobes are given the successive movements in their respective spaces or recesses indicated, all as set forth.

2. In a water meter, pump, or motor, a chamber having measuring recesses or spaces opening therefrom, in combination with a piston having a separate lobe or projection entering each of said recesses or spaces, and adapted to be brought in contact with the walls thereof, and to be held in contact therewith during the movement of the piston by the direct pressure exerted upon the piston, as specified, all substantially as set forth.

3. In water meters, pumps, or motors, the combination of a piston-chamber having measuring spaces or recesses opening therefrom, each of which has an inlet-port and an outlet-port, with a piston having a lobe or projection entering each space or recess adapted to control the exhaust-port thereof and to maintain a contact with the wall of the space or recess, which contact is maintained by the excess of direct pressure in the piston-chamber, as described, all substantially as set forth.

4. In a water meter, motor, or pump, the piston-chamber having measuring recesses or spaces forming a part thereof, a piston, F, having a projection or lobe entering each of said spaces or recesses, which projections or lobes are adapted to be brought successively into contact with the walls of said spaces or recesses, and to be moved therein, and the contact maintained during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, a register, and devices connecting the piston with the register, all substantially as and for the purposes set forth.

5. In a water meter, motor, or pump, the piston-chamber having measuring spaces or recesses forming a part thereof, a distributing-chamber having an inlet, a', the passages or inlet-ports E, connecting the distributing-chamber with the measuring spaces or recesses of the piston-chamber, a piston having a separate or distinct lobe or projection which enters each of said measuring spaces or recesses and is operated or moved and the contact maintained by the excess of pressure, as herein set forth, all substantially as and for the purposes described.

6. In a water meter, motor, or pump, the combination of the distributing-chamber a^2, its inlet a', the piston-chamber D, having
521 measuring recesses or spaces d, the uncontrolled ports or passages E, connecting the distributing-chamber a^2 with the recesses or spaces d, the outlet-ports E′, and escape passages connected therewith, and the piston F, having the lobes or projections f, one for each of the measuring spaces or recesses d, and operated or moved

therein to maintain contact during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, all substantially as described.

7. In a water meter, motor, or pump, the independent or separate base-section containing the inlet-passage a', the distributing-chamber a^2, and the outlet-passage a^3, with the independent or separate section B, containing the piston-chamber D, with the measuring recesses or spaces d, connected with the distributing-chamber and outlet-passage, as described, and the piston F, having a lobe or projection for each of said spaces or recesses, and the bolts for fastening the two sections of the meter together, all substantially as and for the purposes described.

8. The combination of the section A, having the distributing-chamber a^2, the section B, and the removable port-plate B^2, having the ports E.

9. In a meter, motor, or pump, the combination of the section A, having the distributing-chamber a^2, the section B, containing the measuring-chamber, the port-plate B^2, and the packing-ring B'.

10. In a water-meter as a means for communicating the motion of the piston to the register, the mechanism described, consisting of the stationary gear g^6, the revolving gears g^7 g^8, adapted to be revolved around the stationary gear by the piston, and the gear g^9 upon the connecting-spindle.

11. The combination of the piston F, the disk G, the drum or frame g^2, pivoted, as described, to be revolved, and the differential gears inclosed within said drum or case.

12. The combination, in a water-meter, of the piston-chamber D, the piston F, the reducing mechanism or gearing for transmitting the motion of the piston to the registering device contained in a recess in the piston, and the registering mechanism, all substantially as and for the purposes described.

13. In a water meter, motor, or pump, a piston-chamber having measuring spaces or recesses, and a loosely-fitted piston having lobes or projections extending into said spaces or recesses to form by contact with the walls thereof successive discharge-spaces, the said walls being shaped to provide the surface of the piston within the contacting lines of the discharge-spaces with less area than the remainder of the piston, subjected to the direct action of the pressure from behind, whereby the piston or valve may be loosely fitted in the piston-chamber, and by the excess of pressure caused by the difference in area is brought in contact with the walls of the measuring spaces or recesses, maintained in contact therewith, and rotated, all substantially as described.

JAMES A. TILDEN.

Witnesses:
F. F. RAYMOND, 2D.
FRED. B. DOLAN.

522 Fee, $1.40, pd.

(2–172.)

UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the digest of this office of all assignments, agreements, licenses, powers of attorney, and other instruments of writing found of record up to and including July 19, 1886, under or relating to letters patent granted to James A. Tilden, assignor to Hersey Brothers, August 18, 1885, No. 324,503, "rotary fluid meter."

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto [L. S.] affixed this 22 day of July, in the year of our Lord one thousand eight hundred and eighty-six, and of the Independence of the United States of America the one hundred and eleventh.

M. V. MONTGOMERY,
Commissioner.

523 (2–173.)

Assignors.	Assignees.	Date of assignment.	Date of record.	Invention.	Territory assigned.	Liber.	Page.
James A. Tilden.	Hersey Brothers, (firm composed of Charles H. Hersey and Francis C. Hersey), Boston, Mass.	Dec. 20, '84	Dec. 24, '84.	Meters. Appl'n executed Dec. 19, '84. Aug. 18,'85. No. 324,503.	All his right, title, and interest in said invention; patent to issue to assignee; also assigns all extensions and reissue thereof. $1 and other considerations.	N 30.	424
Hersey Brothers: Charles H. Hersey, Francis C. Hersey.	Hersey Meter Company of Portland, Me.	Jan. 2, '86	July 16, '86.	Rotary fluid meter. Aug. 18,'85. No. 324,503. Also application and certain foreign patents.	All their right, title, and interest in said inventions and letters patent and all reissues and extensions thereof. $1 and other considerations.		

[Endorsed:] Serial No., 215,027. Paper No. 2. Abstract of title. Filed Sep. 30, 1886. United States Patent Office, a. Sep. 30, 1886, m., received. 14925. S., '86.

524 UNITED STATES PATENT OFFICE.

In the Matter of the Application of JAMES A. TILDEN for Reissue of Patent No. 324,503, Dated August 13, 1885, for Improvement in Fluid Meters. Filed Sept. 30, 1886. Se. No., 215,027.

Commissioner of Patents, Washington, D. C.

SIR: We hereby appoint Thomas William Clarke and F. F. Raymond, 2d, of the firm of Clarke & Raymond, 29 Pemberton square,

Boston, Mass., our attorneys to prosecute the above-named application, with full powers.

HERSEY METER CO.,
[L. S.] By FRANCIS C. HERSEY, *Treas.*

Boston, Mass., Oct. 4, 1886.

[Endorsed:] Serial No., 215,027. Paper No. 3. Power att'y. Filed Oct. 6, 1886. U. S. Patent Office, Oct. 6, 1886, division XXIII.

525 UNITED STATES PATENT OFFICE.

In the Matter of the Application of JAMES A. TILDEN, Assignor to Hersey Meter Company, for Reissue of Patent No. 324,503, Dated August 13, 1885, for Improvement in Fluid Meters. Filed Sept. 30, 1886. Serial No., 215,027.

29 PEMBERTON SQ., BOSTON, *Oct.* 4, 1886.

Commissioner of Patents, Washington, D. C.

SIR: We hereby appoint James A. Tilden, of Hyde Park, Mass., our associate attorney to prosecute the above application, with full powers.

CLERKE & RAYMOND,
Att'ys for Hersey Meter Company, Assignees of James A. Tilden.

[Endorsed:] Serial No., 215,027. Paper No. 4. Ass'r power of att'y. Filed Oct. 6, 1886. United States Patent Office, Oct. 6, 1886, division XXIII.

526 (2-031.)

Issue division. 215,027.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., *Oct. 12th*, 1886.

James A. Tilden, ass'r, c. o. J. A. Tilden, Hyde Park, Mass.

SIR: Your application for reissue of patent No. 324,513, for improvement in water meters with revolving piston, has been examined and allowed.

The patent will be forwarded to you as soon as practicable in due order of business.

Very respectfully, M. V. MONTGOMERY,
Commissioner of Patents.

527 1886.

Serial No., 215,027. Ex'r Book No. $\frac{147}{157}$.

Reissue No. 10778. Seely.

James A. Tilden, ass'or,
By mesne assignment, to the
Hersey Meter Company of
Portland, Maine,
Of Hyde Park,
County of ——,
State of Massachusetts.
Invention.
Rotary fluid meters.

Parts of application filed.

Petition,	Sept. 30,	1886.
Affidavit,	" "	"
Specification,	" "	"
Drawing, 8 sheets,	" "	"
Old patent,	" "	"
Abstract of title,	" "	"
Cert. deposit, ——.		
Cash, $30, Sept. 30, 1886.		

App. filed complete Sept. 30, 1886.
No. and date of original patent, 324,503, August 18, 1885.
2. Examined Oct. 9, '86. F. A. Seely.
Countersigned: Oct. 11, '86. J. W. Babson, for Commissioner.
Notice of allowance, Oct. 12th, 1886.
Reissued Nov. 2, 1886.
Att'y or P. O. address, Clarke & Raymond, 29 Pemb. Sq., Boston, Mass.
3. Ass'r, J. A. Tilden, Hyde Park, Mass.

528 Class —. 1886.

Contents.

½. Application, 2 papers.
1. Original patent, Sept. 30, '86.
2. Abstract of title, " " "
3. Power att'y, Oct. 6, '86.
4. Ass'r power att'y, Oct. 6, '86.
5.
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7.
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10.
11.
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13.
14. 78.
15. Rotary meter.
16.
17.
18.
19.
20.

Title:

Improvement in water meters
with revolving pistons.

Comp'd:

A. C. Wickware.
J. B. Banks.

[Endorsed:] 10751. D., '88.

537 UNITED STATES PATENT OFFICE.

JAMES A. TILDEN, of Hyde Park, Massachusetts, assignor, by mesne assignments, to the Hersey Meter Company, of Portland, Me.

Water-Meter with Revolving Pistons.

Specification forming part of Reissued Letters Patent No. 10778, dated November 2, 1886. Original No. 324,503, dated August 18, 1885. Application for reissue filed September 30, 1886. Serial No. 215,027.

To all whom it may concern:

Be it known that I, James A. Tilden, of Hyde Park, in the county of Norfolk and State of Massachusetts, a citizen of the United States, have invented a new and useful improvement in fluid-meters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in explaining its nature.

It is well known that a fluid-meter, to be practically and commercially successful, must be capable of measuring and registering the quantity of fluid which passes through it under all conditions, that it must not easily get out of repair, that its construction must be simple, and that its manufacture must be inexpensive. Various meters have been made with some, if not all, of these requirements; but, so far as I am aware, there is not at present in the market any meter which combines all of these features with certain necessary wearing qualities to such an extent that it may be said to be a really commercially successful or practical meter; and while my invention may not be perfect in every respect, yet it has all the requisites of an efficient, desirable, and cheap meter.

The invention is embodied in a fluid-meter comprising a stationary chamber having measuring spaces or recesses opening therefrom, the ends of the chamber being closed by fixed parallel heads, whereby the weight and end-pressure on the piston which moves therein are reduced; a piston of less diameter than that of said chamber accurately fitted between said heads, and having lobes or projections equal in number to the chamber-spaces, each lobe moving in and conforming in shape to its space; an inlet-port for the supply to each measuring-space of fluid under pressure, and outlet-ports at each end of the piston extending from each measuring-space to an escape-passage, whereby the piston is balanced in its function as a fluid-actuated valve. If the piston is placed centrally within the chamber, its irregular peripheral surface will be concentric to the opposed interior surface of the chamber, and the distance between said surfaces will be the radius of the extent of the piston's movement, which movement and its contact result not from mechanical means, but from hydraulic action of the fluid in passing through the meter, during which time the piston is eccentric within the chamber.

The meter can hardly be called a "rotary" meter, because the piston does not rotate on its own axis, although it does revolve about the center of the case, and yet it is quite unlike in appearance any of the ordinary reciprocating-piston meters; but it combines, it may be said, portions of both systems in substantially this manner. The measuring-chamber of the meter is divided or separated upon its outer edge into measuring spaces or recesses, all of which open into the central portion of the chamber, but which may or may not be of uniform size and shape. Each of these spaces has its individual inlet and outlet ports. The part which I call the "piston" has radially-extending portions or lobes, each of which enters its measuring space or recess and does not at any time leave its recess, and has a movement therein that causes it to be brought into contact with one side of its recess near the mouth, and to advance along the side continuously until it reaches the other side of the recess, when it returns across the mouth of the recess or space to its original position. This movement of each lobe in each space or recess alternately exposes and closes the outlet-ports, thereby preventing the flow of liquid from the chamber only after it has entered what may be termed the "measuring" and "discharging" spaces or recesses.

The piston performs a double duty. It not only acts to form measuring-spaces and to discharge their contents, but the portions thereof which cover the outlet-ports also act as the valves of the piston-chamber, in that they serve alternately and in successive order to valvularly control or open and close the outlet-ports; and as it is essential that the piston should move in the piston-chamber with as little friction as possible, I have arranged the outlet-ports in the stationary or fixed heads or plates, so that the piston is balanced as regards end-pressure in the piston-chamber between two opposed or equalizing pressures exerted against its ends or end surfaces.

538 To understand the working of the device it must be borne in mind that the fluid has free access to the chamber—that is, its inlet-ports are never entirely closed; that because of the shape of the wall of the chamber and of the piston the piston is kept in contact with the wall of the chamber at a number of what I call "contact-lines," which form the changing limits of measuring and discharging passages, spaces, or recesses. The number of lines of contact depends, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary, because a full head is maintained in the larger part of the chamber, and it is of course necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by fluid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes, in connection with the portions of the wall which constitute or form the spaces or recesses, also act to separate the outlet-ports from the inlet-ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact-lines—one between the outer surface of the lobe and the wall of the recess and the other between the surface of the inward

projection of the wall and the surface of the piston between the lobes. These lines of contact continually advance until the fluid has been expelled from each space or recess. While, however, this discharge from each space or recess is going on by the movement of the lobe, the space or recess is filling behind the lobe. Of course the number of spaces or recesses which are discharging simultaneously depends upon the entire number of spaces or recesses which the chamber contains, and there may be several recesses or spaces discharging and receiving at the same time. This advancing movement of the lobe in each space or recess does not continue beyond its individual space, but upon reaching the end of that space or recess it returns across the mouth or entrance of its recess or space to its original position, while the piston as a whole, without rotating on or about its axis, moves on a circular path.

The contact-lines of the piston, in the operation of dividing the chamber into measuring spaces or recesses and discharging the same, are always upon the same side of the piston, and these contacting lines are brought successively into operation, not by rotation of the piston, but by the successive reverse movements of the lobes, so that the piston, while appearing like a rotating piston, is in principle like a reciprocating piston, in that each of its lobes or projections is caused to enter a measuring space or recess, advance therein, empty it, and return to its original position, to again advance in the said space or recess and empty. In making this movement the contact between each lobe and the wall is not maintained during the reverse movement of each lobe or projection. The piston in other respects has more of the principle of a reciprocating piston than of a rotating piston, in that each lobe or projection operates as a separate or distinct piston or discharging device in connection with its respective space or recess, so that, the recess or space being filled with liquid, the lobe enters it and presses the liquid therefrom through the outlet-ports. In other words, each lobe or projection does not act to displace the liquid from the spaces or recesses like a plunger, but to discharge the liquid therefrom by an advancing movement from one end of the chamber or recess to the other, like a piston.

In the drawings—

(Here follow diagrams marked pp. 529, 530, 531, 532, 533, 534, 535, & 536.)

Figure 1 represents a side elevation of the machine. Fig. 2 is a plan view of a portion of the meter above the line *x x* of Fig. 1, inverted, showing the piston and upper series of outlet-ports. Fig. 3 is a view, principally in vertical central section, showing, especially, the mechanism for connecting the piston with the registering-train. Fig. 4 is a section upon the line *y y* of Fig. 3, also showing the lower series of outlet-ports and the inlet-ports. Fig. 5 is a view, principally in vertical section upon the lines *z z* of Fig. 4, showing, especially, the relation of the outlet-ports, meter-walls, and spaces or recesses when discharging. Fig. 6 is a plan view of the packing-piece between the base and main sections of the meter. Fig. 7 is a plan

8 Sheets—Sheet 1.

J. A. TILDEN.

Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

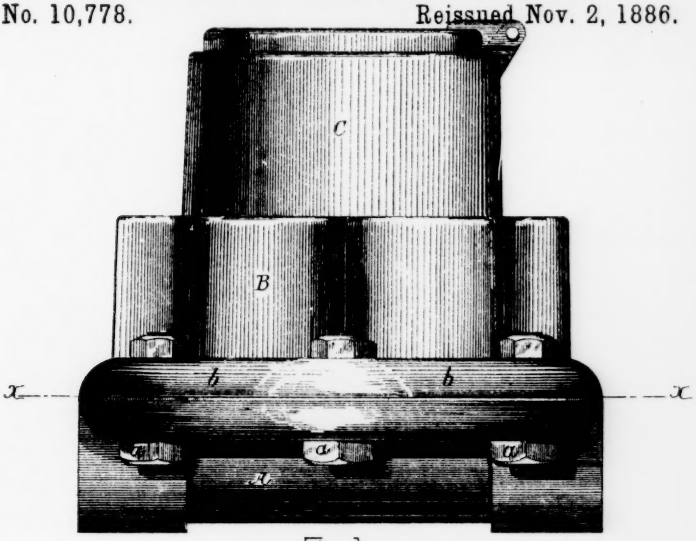
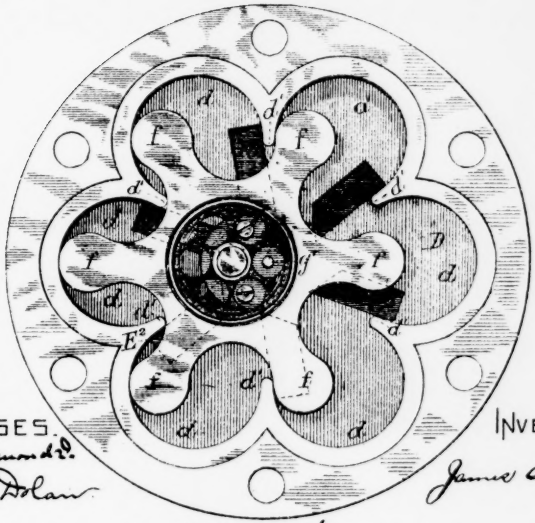


Fig. 1.

Fig. 2



WITNESSES.

F. F. Raymond 2d.

Fred. B. Dolan

INVENTOR.

James A. Tilden

No. 192
Natl. Meter Co.
v.
B'd Water Comm.
p. 529.

8 Sheets—Sheet 2.

J. A. TILDEN.

Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

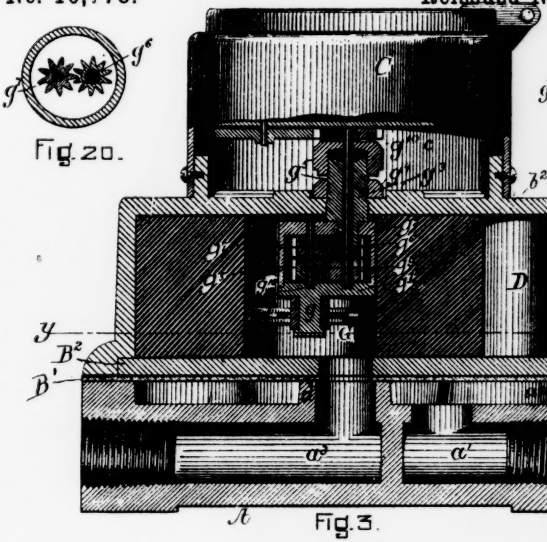


Fig. 20.

Fig. 21.

Fig. 3.

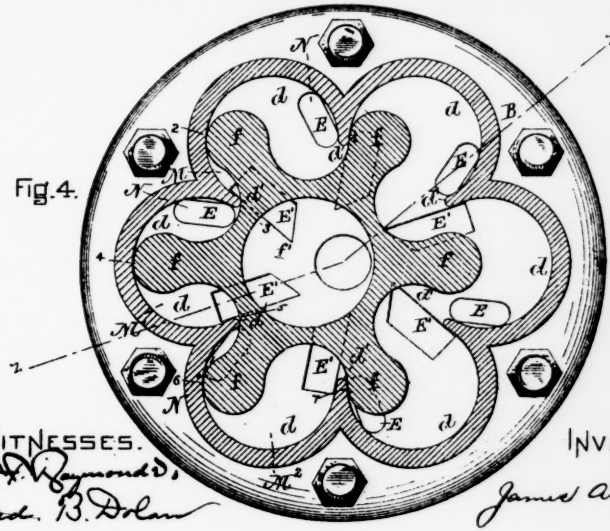


Fig. 4.

WITNESSES.

F. F. Raymond Jr.

Fred. B. Dolan

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James A. Tilden

No. 192 Natl Meter Co. v. Bd. Water Comm. } p. 530.

8 Sheets—Sheet 3.

J. A. TILDEN.

Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

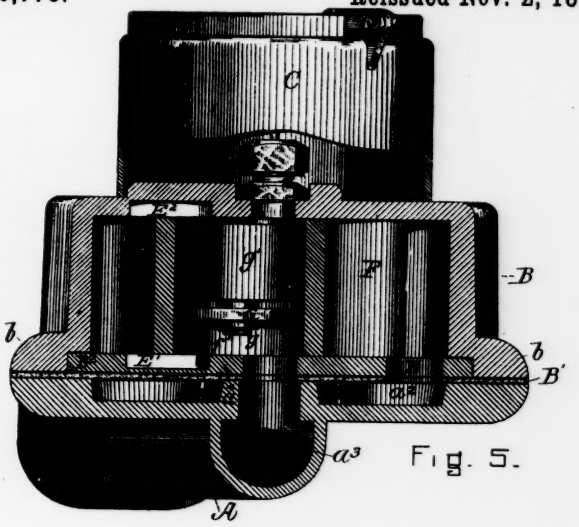

Fig. 5.

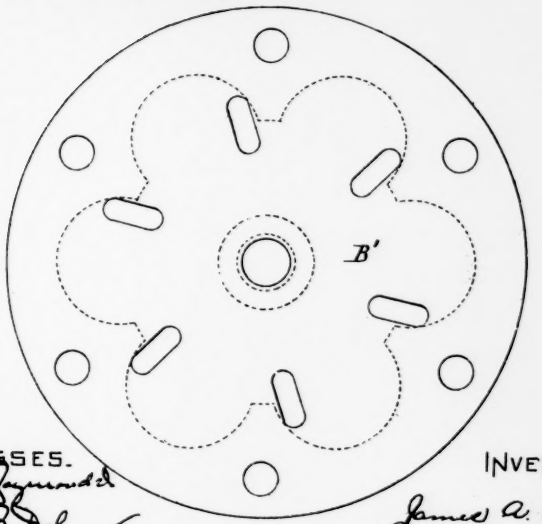

Fig. 6.

WITNESSES.

INVENTOR.

James A. Tilden

No. 192
Natl Meter Co.
vs.
Water Comm.
} p. 531.

8 Sheets—Sheet 4.

J. A. TILDEN.

Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

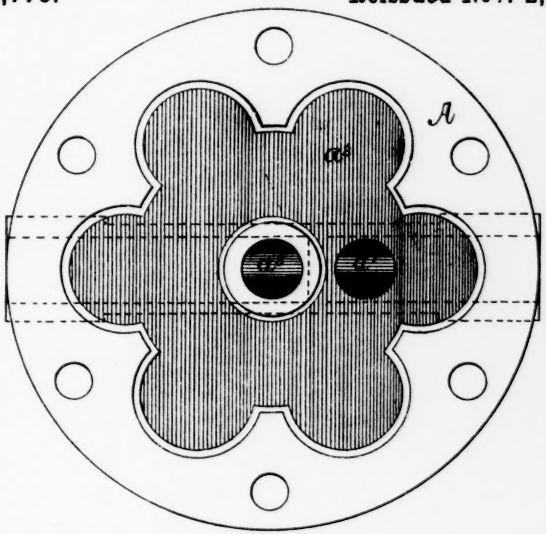

Fig. 7.

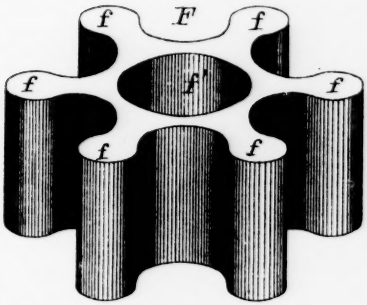

Fig. 8.

WITNESSES

F. D. Raymond Jr.

Fred. B. Dolan

INVENTOR

James A. Tilden

No. 192 Natl Meter Co. vs Bd Water Comrs } p. 532.

8 Sheets—Sheet 5.

J. A. TILDEN.

Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

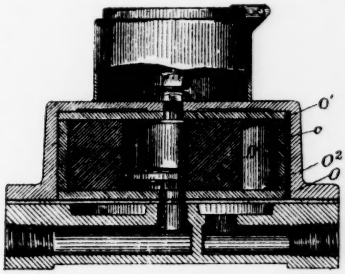

Fig. 9.

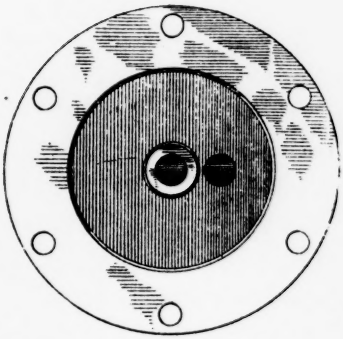

Fig. 10

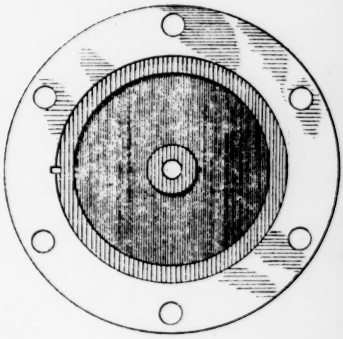

Fig. 11.

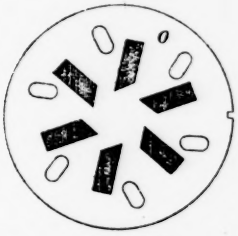

Fig. 12.

WITNESSES.

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8 Sheets—Sheet 7.

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Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

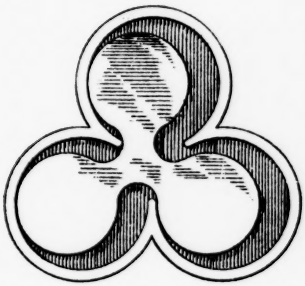

Fig. 16.

Fig. 17.

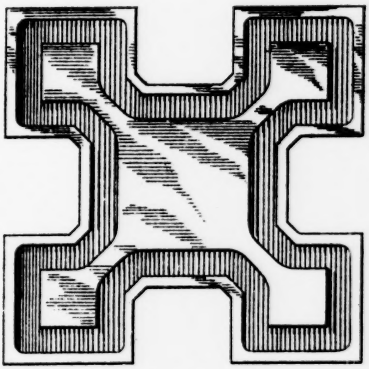

Fig. 18.

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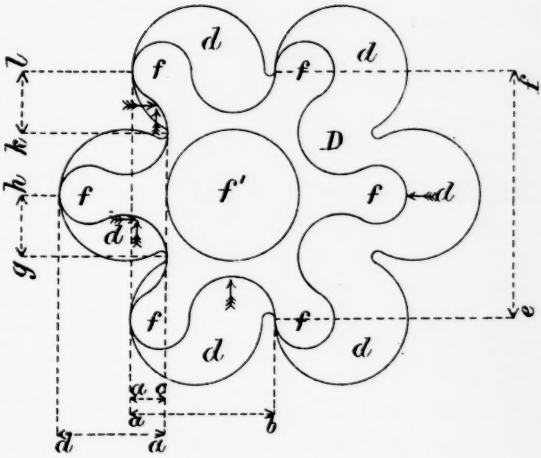
WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

Fig. 17.



a---b = 1.5
a---c = .35
a---d = 1.1
2.95
1.5
Rotative effect 4.425 sq. in.

e---f = 2.6 × 1.5 = 3.90
g---h = .65
k---l = .65
1.30 × 1.5 = 1.95
Contact pressure 1.95 sq. in.

WITNESSES.
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Fred. B. Dolan

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view of the base-section, showing the receiving-chamber and the inlet and outlet passages. Fig. 8 is a perspective view of the piston. Figs. 9 to 15, inclusive, illustrate special details of a modified form of construction. Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction. Fig. 19 is a diagram showing by calculation the differences in pressure which cause the action of the meter. Figs. 20 and 21 are sections of the reducing-gears hereinafter described, and Fig. 22 is a view of the sleeve forming the support of the drum carrying the gears.

Preferably the casing of the meter comprises three principal parts or sections: first, the base-section A; second, the body or main section B, and, third, the shell C, forming the chamber *c*, containing the registering mechanism.

The base-section is made somewhat larger in circumference than the main section, and the two parts are fastened together by bolts *a*, which pass through the flange *b* of the main section. The base-section has the inlet-passage a', which opens into the distributing-chamber a^2 and the outlet-passage a^3. The distributing chamber a^2 occupies almost the entire upper portion of the base, and its object is to provide means for the ready distribution of fluid simultaneously through the various inlet-ports to the main chamber D.

Between the sections A B is a packing-piece, B′, which is shaped as shown in Fig. 6, and is provided with holes for bolt-holes,
539 the inlet-ports, and outlet-passage. Above this packing is a metal plate or head, B^2, which may be called a "port-plate." It rests upon the packing B′, and is held or fastened in place upon it and the upper surface of section A, surrounding the chamber a^2 and the central projection, a^4, by the bolts *a*, the plate being within the main section B, and its edge projecting into a recess formed in the under edge thereof. This port-plate has the holes E, which form the inlet-ports to the chamber D and connect the distributing-chamber a^2 therewith. These ports E are arranged, preferably, to open into each space or recess *d* of the chamber D at one side thereof. The port-plate also has a central hole, which forms a portion of the outlet a^3 and the outlet-ports E′, which are recesses formed in the upper surface of the plate and arranged to extend from one side of each recess or space *d* inward upon converging lines. The chamber D has the measuring recesses or spaces *d* arranged about its outer edge, which open into the central portion, and the projections or portions of the wall of the chamber which form spaces or recesses I have lettered *d*′. The piston F preferably is made of hard vulcanized india-rubber, gutta-percha, or other equivalent material, and has the wings or lobes *f*, which extend radially therefrom. The central hole, *f*′ of the piston forms a part of the outlet-passage, and is large enough to always permit the escape of fluid therefrom into the outlet a^3, regardless of the position of the piston.

In addition to the lower set of outlet-ports, E′, I have formed in the under surface of the head or upper plate, b^2, which forms the top of the main section B, another set of outlet-ports, E^2. (Shown in Figs. 2 and 5.) They are of the same shape and connect the same

parts of the spaces or recesses with the opening f' as the lower exhaust-ports, E'.

It will be seen that each measuring space or recess is connected with the outlet-passage by two outlet-ports, E' E^2, formed by depressions or recesses in the plates or heads B^2 b^2, and arranged so that the fluid in the measuring-spaces escapes between the port plates or heads and the ends of the piston. It will be seen, further, that if one set only of outlet-ports were employed the pressure of the fluid upon one end of the piston would be less than that exerted against the other end, and the piston would be pressed against the head or plate having the outlet-ports, and the resulting friction would interfere with the advantageous working of the piston. To obviate this friction I make use of opposed outlet-ports arranged at opposite ends of the piston, or in the opposite stationary heads of the fixed case, which results in bringing equal balancing pressures upon the piston ends, thus balancing and floating the piston endwise between two opposed fluid-pressures of equal force. There is also arranged in the hole f' a perforated disk, G, (see Figs. 2 and 3,) by which motion is communicated to the shaft which operates the train of gears comprising the registering mechanism. This disk carries at its center a stud, g, which projects downward from the drum g', which is pivoted at g^2 to the screw-sleeve g^3, which passes through the hole in the plate b^2, and is locked thereto by the nut g^4, which screws upon the thread g^5, and the movement of the piston causes the drum to be revolved upon the sleeve. It is necessary, however, as the chamber is of small capacity, and as the motion of the piston is rapid, to reduce the motion of the piston very considerably; and it is desirable to do so in as simple a manner and with as few parts as possible, in order that the construction may be cheap and as little weight of metal used as possible, and I employ for this purpose a train of four gears, one of which, g^6, is stationary, being secured to the end of the sleeve g^3. The gears g^7 g^8 are attached to the drum by the shaft g^{10}, to which they are fastened, and the gear g^7 meshes with the gear g^6. The gear g^8 is arranged to mesh with the fourth gear, g^9, which is fastened to the spindle g^{10}, which communicates motion to the registering-train. As the drum revolves about the sleeve g^2 it is obvious that if the gear g^7 has more or less teeth than the gear g^6 it will be caused to move each revolution of the drum a certain portion of a revolution, depending upon the difference in the number of teeth between the two gears. It is also obvious that if the gears g^8 g^9 have the same number of teeth as the gear g^7 a movement of rotation will be communicated to the shaft or spindle g^{10}.

If it is desired to still further reduce or change the rate of the rotation of the shaft g^{10}, then the gear g^8 may have more or less teeth than the gear g^7, as the case may be, as also may the gear g^9; and in the drawings I have represented the gear g^6 as provided with ten teeth, the gear g^7 with nine teeth, the gear g^8 with eight teeth, and the gear g^9 with nine teeth, so that upon every complete revolution of the drum the shaft g^{10} is moved one eighty-first of a revolution, and it therefore requires eighty-one revolutions of the drum to make

one complete revolution of the shaft, the spindle or shaft g^{10} being used, of course, to operate any registering mechanism.

It will be seen by this construction of gearing that the drum g', carrying the gears g^7 g^8, revolves from left to right, and that the gear-wheels g^7 g^8, being carried by the drum, are caused by the meshing of the gear g^7 with the stationary gear g^6 to turn from right to left, and that the meshing of the gear g^8 as it is turned upon its revolution about the gear g^9 causes the gear g^9 to be moved, as above specified, one eighty-first of a revolution for each revolution of the drum and the gears g^7 g^8 about it.

It will be observed that by making the mechanism for reducing the movement of the piston in compact form I am enabled to place it in the measuring-chamber and within the hole formed in the piston, thereby economizing space.

540 In operation the liquid passes into the distribution-chamber a^2, and through the inlet-ports E into the chamber D, moving the piston toward one side of the chamber, and causing the formation of measuring or discharge spaces by the contact of the various portions of the piston with the chamber-wall. This position of the piston is well shown in Fig. 4, where there have been formed six divisions of the three spaces or recesses d by the contacting of the piston at the points 1, 2, 3, 4, 5, 6, and 7, and of these three recesses or spaces two—namely, the small spaces marked M and the space M'—are connected by the discharge-ports E' E' E^2 E^2 with the escape-passage, while the space M^2 is about to be; but the fluid, upon being admitted to the chamber under pressure, not only immediately moves the piston to the position shown in Fig. 4, which is one of any number of positions which it might cause it to assume, and from such position it causes it to advance or move so that the lobes which are in contact with the wall of the chamber are caused to continue that contact until they have expelled all the fluid which is in the discharge spaces or recesses before them, when each lobe in succession will leave the surface and return upon an arc of a circle to a position where it again comes in contact with the surface of the wall of the chamber on the opposite side from that which it left, and again advances and expels the fluid from its recess or space.

It will be seen that each recess or space becomes in succession a discharge space or recess, and that as soon as the piston has moved sufficiently to uncover the inner end of its outlet-ports it begins to discharge through such ports into the escape-passage a^3, and that while a portion of each space or recess is discharging another portion is also receiving the liquid under pressure through the ports E.

To illustrate why with the arrangement of the inlet and outlet ports described the piston is compelled to make the motion that it does, I have shown in Fig. 19 by diagrams the differences in pressure upon both sides of the piston and the extent of the surface which is subjected to the direct pressure of the entering fluid.

It is obvious that the chamber D, excepting the spaces which are discharging, is filled with fluid under pressure, and that the pressure for moving the pistons is that which enters each space or recess which is being discharged and behind the respective discharging-

lobe. For instance, referring to Fig. 4, the piston is receiving motion from the fluid which enters the spaces through the ports marked N N N, but from no other. It is not necessary that the main chamber and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses, from three upward, and that they may be of any size and of different sizes for the same piston, the only difference to be observed being that the piston and chamber-wall must be so shaped as to provide the contact-lines in the surface of the piston or chamber wall, whereby the formation of measuring-chambers is effected.

In Fig. 16 I have illustrated a piston having three lobes in a chamber having three measuring and discharge spaces or recesses. In Fig. 17 I have shown a piston with two large lobes and two small ones and a chamber with corresponding recesses or spaces. In Fig. 18 I have represented the piston as having square lobes and the chamber with spaces which substantially follow the shape of the lobes, the only variation being that they are rounded at the corners.

It will be obvious from what I have stated that the meter is very simple in construction; that it has but very few parts, which require but little machine-work, and are easily fitted and put together; and it is also apparent that a substantially perfect registration of the liquid which passes through the meter is obtained, as it all is obliged to pass into the measuring-spaces, which are successively emptied. It will be seen, further, that this measuring of the liquid takes place very rapidly and with the minimum of friction of the wearing parts, and that the construction of the piston and chamber is such that sediment cannot interfere with the proper working of the invention, and that wear, up to a certain extent, improves the efficiency of the meter, in that it causes the contacting surfaces of the piston and chamber to fit themselves as they wear.

To still further cheapen the manufacture, I show in Figs. 9 to 15, inclusive, a construction which enables me to use, instead of the comparatively expensive casing of composition, an iron casing. This I accomplish by making the base-section entirely of iron, employing two composition port-plates, O O′, the plate O being like that described, and the plate O′ having simply the exhaust-passages E^2. The piston is made of hard rubber, gutta-percha, or other like non-corrosive material, and the wall O^2 (see Fig. 14) of the chamber D is formed of a ring or sleeve of gutta-percha, hard india-rubber, or even of composition, which is fitted into the iron shell or casing of the main section. This non-corrosive movable wall of the chamber is fastened to the casing by means of a key, *o*, which enters a groove in the ring and a corresponding one in the inner surface of the iron shell, or in any other suitable way. A view in perspective of the movable wall is shown in Fig. 14.

It will be seen that by this construction not only can an iron shell be employed, but that the principal wearing parts—namely, the port-plates, the piston, and the wall of the chamber—may be easily removed and others substituted therefor. The port-plates are also held in place by suitable keys, or in any other desirable way, and

it will be observed that they extend upon the two end surfaces of the removable wall. (See Fig. 9.)

While the invention as shown in the drawings represents
541 a piston which, while not rotating, moves in a circular path, yet by changing the forms of the piston lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, elliptical, or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston, the principle of its action is not changed, as the lobe or portion of the piston which penetrates the measuring-space will have a continuous movement in said space, whether its path be circular, square, rectangular, elliptical, or of any other shape. In this construction the piston in motion is held in changing lines of contact with the internal irregular surface of the fixed case by hydraulic action, as illustrated by the diagram, Fig. 19, and the calculation there noted, so that, while the piston is controlled in its movement by contact with the fixed case, it is free to depart from such contact, being held thereto only by fluid-pressure, and not by mechanical means—such as cranks, links, abutments, &c.—and so can move over obstructions interposing between the irregular peripheral surface of the piston and the opposed surface of the fixed case without causing the piston to jam and cease motion and without risk of breakage or of strain of any part.

Of course the invention can be utilized as a pump or motor, if desired.

Having thus fully described my invention, I claim and desire to secure by letters patent of the United States—

1. A fluid-meter having a stationary piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, and having a movable piston fitted, as described, in said chamber, with lobes conforming to the chamber-recesses, each lobe entering and moving in but one recess, and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, and having parallel stationary heads or plates, whereby end-pressure on the piston is relieved and weight of the moving parts is reduced, substantially as set forth.

2. A fluid-meter having a stationary piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, and having a movable piston fitted, as described, in said chamber, with lobes conforming to the chamber-recesses, each lobe entering and moving in but one recess, and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, and having the opposed arrangement of the ports, whereby balanced valvular action is effected, substantially as set forth.

3. A fluid-meter having a stationary piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, a movable piston fitted, as described, in said

chamber, with lobes conforming to the chamber-recesses, each lobe entering and moving in but one recess, and adapted to be held and moved in contact with the walls thereof by hydraulic action, as specified, parallel stationary heads or plates, whereby the weight of the piston is reduced and end-pressure thereon is relieved, and an opposed arrangement of the ports, whereby balanced valvular action is effected, substantially as described.

4. In a fluid-meter, the piston-chamber having measuring recesses or spaces forming a part thereof, a piston, F, having a projection or lobe entering each of said spaces or recesses, which projections or lobes are adapted to be brought successively into contact with the walls of said spaces or recesses and to be moved therein, and the contact maintained during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, a register, and devices connecting the piston with the register, all substantially as and for the purposes set forth.

5. In a fluid-meter, the piston-chamber having measuring spaces or recesses forming a part thereof, the stationary port-plate B^2, a distributing-chamber having an inlet, a', the passages or inlet-ports E in the said stationary port-plate B^2, connecting the distributing-chamber with the measuring spaces or recesses of the piston-chamber, and a piston having a separate or distinct lobe or projection, which enters each of said measuring spaces or recesses and is operated or moved and its contact maintained by the excess of pressure, as herein set forth, all substantially as and for the purposes described.

6. In a fluid-meter, the combination of the distributing-chamber a^2, its inlet a', the piston-chamber D, having measuring recesses or spaces d, the uncontrolled ports or passages E, connecting the distributing-chamber a^2 with the recesses or spaces d, the outlet-ports E' E^2 and escaped passage connected therewith, and the piston F, having the lobes or projections f, one for each of the measuring spaces or recesses d, and operated or moved therein to maintain contact during the discharge of the liquid from each space or recess by the direct pressure in the piston-chamber, as specified, all substantially as described.

7. In a fluid-meter, the independent or separate base-section containing the inlet-passage a', the distributing-chamber a^2, and the outlet-passage a^3, with the independent or separate section B, containing the piston-chamber D, having the measuring recesses or spaces d, connected with the distributing-chamber and outlet-passage, as described, and the piston F, having a lobe or projection for each of said spaces or recesses, and the bolts for fastening the two sections of the meter together, all substantially as and for the purposes described.

542 8. The combination of the section A, having the distributing-chamber a^2, the section B, and the removable port-plate B^2, having the inlet-ports E and the outlet-ports E'.

9. In a meter, the combination of the section A, having the distributing-chamber a^2, the section B, containing the measuring-chamber, the port-plate B^2, and the packing-ring B'.

10. In a fluid-meter, as a means for communicating the motion

of the piston to the register, the mechanism described. consisting of the stationary gear g^6, the revolving gears g^7 g^8, adapted to be revolved around the stationary gear by the piston, and the gear g^9 upon the connecting-spindle.

11. The combination of the piston F, the disk G, the drum or frame g^2, pivoted as described, to be revolved, and the differential gears inclosed within said drum or case.

12. The combination, in a fluid-meter, of the piston-chamber D the piston F, the reducing mechanism or gearing for transmitting the motion of the piston to the registering device contained in a recess in the piston, and the registering mechanism, all substantially as and for the purposes described.

13. A fluid-meter having a piston-chamber with measuring-recesses opening therefrom, each separately provided with inlet and outlet ports, and having a piston fitted and moving as and for the purpose described, with lobes conforming to the chamber-recesses, and serving alternately and in successive order to valvularly control or open and close the outlets formed in the heads and piston.

JAMES A. TILDEN.

Witnesses:
F. F. RAYMOND, 2D.
FRED. B. DOLAN.

543 DEFENDANT'S EXHIBIT FILE-WRAPPER AND CONTENTS NASH REISSUE. S. G. C., Sp. Ex.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the reissue letters patent granted Lewis Hallock Nash, assignor to the National Meter Company, February 8, 1887, number 10806, for improvement in rotary water meter.

Seal Patent Office, United States of America.

In testimony whereof I, Benton J. Hall, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 2d day of June, in the year of our Lord one thousand eight hundred and eighty-eight, and of the Independence of the United States the one hundred and twelfth.

BENTON J. HALL,
Commissioner.

544 $30.

Power of Attorney.

The Commissioner of Patents:

The undersigned, Lewis Hallock Nash, of Brooklyn, Kings county, New York, as patentee, and the National Meter Company, as assignee of said patent, hereby appoint the firm of John-

son and Johnson, of Washington, D. C., the surviving member of which firm is Albert E. H. Johnson, their attorneys, with full power to prosecute this application for reissue of letters patent No. 211,582, to make amendments therein, to receive the patent when granted, and generally to do and perform all acts which are essential in the proper conduct of this application before the Patent Office.

LEWIS HALLOCK NASH.
NATIONAL METER COMPANY,
[L. S.] By JOHN C. KELLEY, *President.*

545 *Petition.*

To the Commissioner of Patents:

Your petitioner, Lewis Hallock Nash, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, prays that he may be allowed to surrender the letters patent for an improvement in rotary water meters, granted to him January 21, 1879, No. 211,582, as assignor to National Meter Company, a corporation organized under the laws of the State of New York and doing business in the city of New York, on whose behalf and with whose assent this application is made, is now sole owner by assignment, and that letters patent may be reissued to the said National Meter Company for the same invention upon the annexed amended specification. With this petition is filed an abstract of title, duly certified, as required in such cases.

LEWIS HALLOCK NASH.

Assent of the Assignee.

The undersigned, assignee of the entire interest in the above-mentioned letters patent, hereby assents to the accompanying application.

NATIONAL METER COMPANY,
[L. S.] By JOHN C. KELLEY, *President.*

546 To all whom it may concern:

Be it known that I, Lewis H. Nash, late of South Norwalk, Connecticut, but now of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful improvements in water meters, and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings and to letters of reference marked thereon, which form a part of this specification.

To obtain accuracy of measurement in a water meter with a construction specially adapted for durability of operation and by which a positive displacement of the water is effected without impeding the flow and interrupting the pressure of the head is the object of my invention.

Water meters adapted with reciprocating pistons, while effecting accurate measurement, have the disadvantage of interfering with the flow, and as a consequence entail the loss of pressure in the flow.

In my improved meter I use a piston adapted to have an eccentric or side-rocking motion across the center of a cylinder chamber to effect its division at two or more points into receiving and discharging spaces. The piston operates with two or more continually changing points or lines of bearing or contact with two or more points or contact bearings of the cylinder at different points at the same time, by which the receiving and discharging spaces of the cylinder are caused to continually change their volume with an unobstructed flow and a positive displacement of the water from the discharging space of the cylinder by the rocking of the
547 piston from one bearing point to another across the chamber of the cylinder.

With this eccentric or side-rocking action the piston also revolves around its own center, and both these movements are effected by the relative shape of the piston and cylinder and by the direct action of the water upon the piston, for as the piston rocks from one bearing point to another directly across the center of the cylinder it is at the same time revolved to effect the measurement of the water passing into and from the cylinder spaces, and to accom-odate this eccentric or side-rocking motion of the piston it must have a free or shifting connection with the crank or mover of the registering mechanism.

The continually changing points or lines of bearing of the piston and cylinder are formed by alternate projections and recesses, and the eccentric or side-rocking movement of the piston is governed by the extent of the projecting bearing points and the depth of the recesses, so that in the rotation of the piston around its own center one or more projecting bearing points of the piston will pass into corresponding recesses at one point of the cylinder and in contact with and over one or more projecting bearing points of the cylinder at a different point, thereby always maintaining a direct contact of the piston and cylinder at two or more dividing points within the continually changing cylinder spaces and obtain thereby a continuous flow without interfering with the pressure of the head.

The object of these continually changing points or lines of contact at different parts of the piston and the cylinder and of the continually changing volumes of the receiving and discharging spaces formed thereby is to allow the water to flow through a valve into and from these spaces as they fill and discharge with-
548 out impeding its flow or lessening its force.

In this connection and for effecting this operation the valve may be formed with and constitute a part of the piston, or it may be separate therefrom and controlled by a connection therewith.

The valve is arranged so that the cylinder spaces on one side of the piston as it revolves have free inlet for the water through one set of the valve ports, while the spaces on the other side of the piston have free outlets for the water through the other ports of the valve,

causing the piston to move with the flow. In this operation the valve opens some and closes others of the ports in succession in such a manner as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the eccentric or side-rocking and rotary movements of the piston, and thereby avoid any undue lateral pressure of the water upon the piston. This result is accomplished in a more satisfactory manner by increasing the number of the bearing points or lines of the cylinder and piston, as shown in Fig. 3. When the valve is arranged within the piston it is formed by inlet and outlet openings or ports in the ends of the piston, communicating by means of passages in or through the piston with the spaces of the cylinder. These end openings or ports communicate with corresponding openings or ports in the ends of the cylinder, which form the inlet and outlet ports thereof.

In the arrangement of the valve separate from the piston the latter has no inlet and outlet ports; but these are formed within a case communicating with the cylinder and operate in the same manner with respect to the constantly changing cylinder spaces, and the action of such separate valve is the same as one formed within the piston, and its motion is controlled by any suitable free attachment with said piston.

The results of these different arrangements of valves are identical, and any suitable form of valve may be used that will operate with a periodic relation to the movements of the piston, so as to give a uniform flow and a uniform pressure upon the working parts.

Referring to the drawings—

Figure 1 represents a vertical section of a water meter embracing my invention.

Figure 2, a top view with the case removed, showing one of the cylinder ports.

Figure 3, a similar view, the cylinder head being removed, showing one form of the cylinder-bearing lines or points in connection with the rotary and side-rocking piston co-operating therewith, and in which the valve is shown as being within the piston, as in Figs. 1 and 2.

Figure 4, the rotary and side-rocking piston with its inclosed valve.

Figure 5, a partial side view of the same, showing the end ports communicating with the lateral passages.

Figure 6, a perforated device at the cylinder chamber inlet port, adapted to form a close-wearing joint for the piston.

Figure 7, a vertical section of a modified form of meter to illustrate the arrangement with the rotary and side-rocking piston of a valve separated therefrom, but controlled by the motions of said piston.

Figure 8, the arrangement of the inlet and outlet passages into and from the cylinder chamber and a valve separated from the piston, taken on line *a a* of Fig. 7.

Figure 8*a*, section on line *b b*, and figure 8 *b* the separate valve.

Figures 9, 10, and 11 are modified forms of the cylinder-bearing points or lines and the corresponding forms of side-rocking and rotary pistons adapted for co-operation therewith; and

Figure 12 shows the direction of the line of pressure upon the piston in relation to its continually changing motion and the divided cylinder spaces.

The case I prefer to make in two parts, one, A, of which forms the head or base and has the inlet and outlet passages, which communicate with the cylinder-chamber ports, while the other part, B, forms the inclosing case and carries the dial mechanism.

The cylinder C is secured to the base in any suitable way, leaving a space, D, between its walls and the case B, which space communicates with the outlet passage E, while the inlet passage F communicates with the cylinder inlet port by an opening or openings, G, in the base.

The case B may or may not be used, but when it is it serves to form the space D surrounding the cylinder and to relieve the working parts from undue pressure. In Fig. 7 the construction does not require the inclosing case.

The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses *a a'* and projections *b b,'* of such form or configuration as to allow of the rotation of the piston, not only upon its own axis, but around and across the center of the cylinder, and the space within the cylinder must be of such form and sufficiently larger than the piston H to allow it to have this compound
551 motion. The object of this compound motion is to form bearing points or lines of contact of the piston with the cylinder walls, on opposite sides thereof, at the same time, as shown in Figs. 3 and 12, whereby to divide the cylinder into receiving and discharging spaces. Of whatever form these alternate recesses and projections, they must be such that while they are in contact upon one side of the cylinder they must also at the same time have a contact at the opposite or a different side of said cylinder, and in this way divide the cylinder into spaces. In this contact it will be observed that upon one side of the cylinder and piston such contact takes place between a recess and projection or immediately between these points, while upon the opposite side such contact is made by corresponding projections, as shown in Figs. 3 and 12. Intermediately between these points of bearing and division it is advantageous that the cylinder spaces *c* should communicate by the depression *c'* whereby to prevent the choking of the flow and insure a uniform action of the piston.

The compound motion of the piston and the contacting dividing points are due to the fact that the piston has one or more less points of projection than the cylinder.

When the valve is formed within the piston, as shown in Figs. 1, 2, 3, 4, and 5, the heads of the cylinder have inlet and outlet ports, J and K, which must have such form as to act in connection with ports in the piston to form a valve. As shown in these figures, the valve is formed within or is a part of the piston, and it consists of

ports *d d'* in the ends of the piston communicating with lateral passages *e e'*, which communicate with the spaces *c* of the cylinder, which form the receiving and discharging divisions.

552 The ports *d'* receive the water from the cylinder port J and discharge it into the cylinder spaces *c* through the lateral passages *e'*, while the ports *d* discharge the water from the cylinder spaces through the passages *e*, the water flowing from the valve ports *d* through the cylinder port K, whence it passes into the surrounding space D and out through the discharge pipe at E.

With this construction of valve I deem it advisable to use a self-adjusting perforated device, L, as the inlet port, which is carried and held against the piston by the flow of the water against its perforated end, causing the opposite end to maintain a close joint with said piston to take up the wear.

The function of the valve is to regulate the flow of the water in and out of the spaces of the cylinder in such manner as to produce the compound rotation and cross-movement of the piston, and this function can be made operative whether the valve be arranged within the piston as described or separate from and connected with it, as shown in Figs. 7 and 8 of the drawings, it being only necessary that the motion of the valve should be controlled by the compound motion of the piston in any arrangement; and I do not wish to confine myself to either of the specific arrangements of the valve shown or to any specific construction of such valves in relation to the piston so long as the valve and the piston co-operate to produce the results stated.

The valve shown in Figs. 7 and 8 consists of revolving cylinder M, which, by a partition, divides the inlet from the outlet and is supported by a fixed stem, *f*, within its seat. The water enters through the top of the valve by the ports *h* and passes out through a side port, *g*, in said valve into corresponding ports *i* in the

553 valve seat, thence through the passages *j j* into the filling spaces *c* of the cylinder, and from the discharging spaces it passes through the passages *j' j'* and the ports *i'* in the valve seat through the port *g'*, and escapes through the bottom of the valve into the discharge pipe.

Any of the various forms of the piston shown may be used with the separate valve by making the number of the inlet and outlet ports of the valve seat to correspond to the number of the bearing projections of the cylinder. In the arrangement of the separate valve it is operated by a crank or slotted disk, *m*, and a pin, *n*, Fig. 7, on the piston, or any other suitable connection may be made that will allow of the side movement of the piston. The piston is connected to the dial mechanism by a pin, *o*, engaging by a free action with or operating an arm, *p*, of the train of the interior gear, whereby the rotations of the piston are recorded by the usual dial indices.

The recording device is mounted in a separate outside case and connected with an interior train by means of a shaft through a stuffing box, as in ordinary dry dial attachments.

It is required, in order to get the best results, that the valve should open and close its inlet and outlet ports in succession in

such a manner as to keep the line of pressure as nearly as possible at right angles to the direction of the motion of the piston. By the "line of pressure" I mean a line connecting the points of the division which separate the inlet from the outlet spaces *c* of the cylinder, as shown by the line *z* in Fig. 12, and by a "line of motion" I mean a line which is tangent to the path of the axis of the piston at any point of such path, as shown by the arrow *y* in said figure, and in this way these lines continually change
554 their position as the piston rotates and rocks sidewise.

I prefer to make the piston of hard rubber, but it may be made of any suitable material, and either in one piece with the valve, or the latter may be made in the form of a plug and inserted within an opening in the piston.

I have described and prefer in practice that the piston shall have the compound motion described, but it is obvious that the piston may be fixed and the cylinder be made to have the relative compound motion; so, in like manner, both the cylinder and the piston may have a separate conjoint motion, yet retaining the same relation to each other. In the use of the meter the inlet may become the outlet, and *vice versa*. It is also contemplated to use the machine as a motor or as a pump, and in the former case the power is taken from the piston through a crank shaft or otherwise, and in the latter case the power is applied to the piston in the same manner.

The self-adjusting port device L (shown in Figs. 1 and 6) is adjustably seated within and forms said port and has side walls, with one end perforated and its other end open and provided with a rim, which bears upon the end of the piston, to effect the object stated.

An important feature of my invention embraces the combination, with a piston adapted to operate substantially as described, of a valve controlled thereby irrespective of its specific construction or arrangement.

When an enclosing case is used in connection with the cylinder they are so arranged in relation to each other as to form an intermediate surrounding space communicating with the end parts of the cylinder chamber and with the outlet port of the receiving end of the piston for the purpose stated.

555 It will be seen that the connection of the piston with the registering mechanism is such as to allow of a free or shifting action to accommodate the side-rocking movements of the piston across the center of the cylinder chamber and maintain a driving relation with the dial mechanism.

I do not claim broadly a piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, as a motor having a piston of substantially such construction and movement within a cylinder

chamber having such construction is shown and described in the English patent of Elijah Galloway, December 14, 1846, number 11485; but what I do claim is said elements in combination with additional elements, as hereinafter specified, thereby limiting my claims to the novel features embraced in my meter.

I therefore claim—

1. A piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into
556 receiving and discharging spaces *c c*, which communicate with the inlet and outlet, combined with a stationary top and bottom end plate in said cylinder chamber, fitted to make easy working joints with the respective ends of said piston, and with valves to coact with the piston in receiving and discharging water.

2. A piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, combined with a top and bottom end plate in said cylinder chamber, and with suitable valves in both ends of said chamber or piston, by means of which the water is caused to flow over both ends of said piston.

Erase & insert A, Jan. 11, '87.

3. A piston for water meters, pumps, and motors provided with internal water passages and having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet.

4. A piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means
557 of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, said piston having a free move-

Words and sentences enclosed between rules erased in copy.

ment within said cylinder, controlled only by the shape of the cylinder, the shape of the piston, and the flow of water through the meter.

5. A piston for water meters, pumps, and motors composed of hard rubber, having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet.

Erase & insert A[1], Jan. 11, '87.

6. A piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, combined with ports controlled by said piston itself in its motion within said chamber.

558 7. The piston of a water meter, pump, or motor constructed with alternate recesses and bearing points or projections *a* and *b* and a cylinder chamber having alternate wall recesses and bearing points or projections *a'* and *b'*, adapted to intermatch with each other at one or more bearing points at one side of the cylinder and allow the projections of each part to bear upon and to pass each other at two or more points at a different side of the chamber, to allow the piston to revolve while it also rocks in constantly changing lines across the center of the cylinder chamber, for the purpose stated.

8. The piston of a water meter adapted to have an eccentric or side-rocking movement across the center of the cylinder chamber A [mechanism]* and a revolving motion, combined with a registering mechanism by means of a free or shifting connection acting with the continually changing side-rocking movements of the piston while maintaining a driving relation with the dial mechanism.

9. The combination, with a piston having an eccentric or side-rocking motion across the center of the cylinder chamber and
559 a revolving motion around its own center to divide the cylinder at two or more bearing points on its sides, of a valve controlled by the movements of said piston and adapted to open and to close receiving and discharging ports in succession to effect the purpose stated.

10. A rotary piston having a valve formed therein by oppo-

* Word enclosed in brackets erased in copy.
Words and sentences enclosed between rules erased in copy.

site end ports or depressions and adapted to act in connection with receiving and discharging ports or passages in the cylinder chamber to form a valve and piston into and through which the water entering at the inlet cylinder end ports passes through one end of the valve into the cylinder on one side thereof and, re-entering the valve from the other side of said cylinder, passes out at the opposite end ports of said valve to effect the purpose stated.

11. A rotary valve piston having opposite end ports *d d'*, communicating with the piston sides by diagonal passages *e e'*, in combination with a cylinder having receiving and discharging ports communicating with said opposite valve end ports and with the receiving and discharging spaces of said cylinder, whereby said valve opens some and closes others of its ports in succession, and to effect the equalization of the pressure of the water at right angles to the direction of the side-rocking and rotary movements of the said valve piston, as stated.

12. The inlet device L, having side walls, a perforated end, and an open-end bearing rim seated adjustably in and forming the inlet port J of the cylinder chamber, in combination with the rotary piston, against one end of which the said device bears, for the purpose stated.

13. The spaces or recesses *c'* in the walls of the cylinder between the bearing points *b'* and the recesses *a'*, in combination with
560 the piston, having alternate bearing points and recesses whereby to prevent the choking of the flow and insure a uniform action of a piston adapted for operation with a side-rocking motion across the center of the cylinder and a rotary motion around its own center.

In testimony that I claim the foregoing I have affixed my signature in the presence of two witnesses.

LEWIS HALLOCK NASH.

Witnesses:
H. W. BRINCKERHOFF.
WILLIAM C. WESTERVELT.

561 STATE OF NEW YORK, }
County of Kings, } *ss:*

Lewis Hallock Nash, the above-named petitioner, being duly sworn, deposes and says that he does verily believe himself to be the original and first inventor of the improvement set forth and claimed in the foregoing specification and for which improvement he solicits a patent.

That deponent does not know and does not believe that said improvement was ever before known or used.

That deponent is a citizen of the United States of America and resides at Brooklyn, in the county of Kings and State of New York.

That deponent verily believes that the letters patent referred to in the foregoing petition and specification and herewith surrendered are inoperative or invalid in part for the reason that the specification thereof is defective, and that such defect consists particularly

in the first claim thereof, which claims more than the petitioner had a right to claim as new, said claim reading as follows: "A piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the center of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet;" which invention I do not desire to claim in my proposed reissue because the same is described in English letters patent No. 11485, dated December 14, 1846.

562 And deponent further says that the error which renders such patent so inoperative or invalid in part arose from inadvertance or accident or mistake, and without any fraudulent or deceptive intention on the part of deponent.

That the following is a true specification of the error which it is claimed constitutes such inadvertance or accident or mistake relied upon, viz: The first claim of said patent No. 211,582 is too broad in view of English letters patent No. 11485, granted to Elijah Galloway December 14, 1846.

That such error so particularly specified arose or occurred as follows: By reason of said English patent not being cited as a reference to the application upon which his said patent No. 211,582 was granted and because said English patent was not in the class to which his said application was assigned for examination and because said English patent was unknown to said applicant and, as he believes, to his attorneys until within the last month.

And deponent further declares that the description of his said invention as found in his said patent is sufficiently full, clear, concise, and exact in terms to distinguish his improvements from the invention set forth in the said Galloway patent, and upon such showing he now comes with his claims amended and restricted in their definition of his invention in the light of this prior English patent, and he avers that such restricted definition of his invention is intended by its specific terms to distinguish his improvements from thos- described in said Galloway patent and in lieu of his broad first claim before mentioned.

LEWIS HALLOCK NASH.

Sworn and subscribed to before me this 14th day of December, A. D. 1886.

M. F. H. SMITH,
[L. S.] *Notary Public, Kings County.*

[Endorsed:] Serial No., 222,012. Paper No. ½. Application. Filed Dec. 18, 1886. In the United States Patent Office. Petition of Lewis Hallock Nash for reissue of letters patent for improvement in rotary water meters. Dated December 14, 1886. United States Patent Office, Dec. 18, 1886. Received.

563 No. 211,582.

The United States of America to all to whom these presents shall come:

Whereas Lewis H. Nash, of Brooklyn, New York, has presented to the Commissioner of Patents a petition praying for the grant of letters patent for an alleged new and useful improvement in rotary water meters, he having assigned his right, title, and interest in said improvement to National Meter Company of New York, New York, a description of which invention is contained in the specification, of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of law in such cases made and provided; and

Whereas, upon due examination made, the said claimant is adjudged to be justly entitled to a patent under the law:

Now, therefore, these letters patent are to grant unto the said National Meter Company, its successors or assigns, for the term of seventeen years from the twenty-first day of January, one thousand eight hundred and seventy-nine, the exclusive right to make, use, and vend the said invention throughout the United States and the territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the city of [L. S.] Washington, this twenty-first day of January, in the year of our Lord one thousand eight hundred and seventy-nine, and of the Independence of the United States of America the one hundred and third.

A. BELL,
Acting Secretary of the Interior.

Countersigned:
H. E. PAINE,
Commissioner of Patents.

564 Printed spec's of old pat. exhausted.

565 [Endorsed:] Serial No., 222,012. Paper No. 1. Abst. of title & orig. pat. Filed Dec. 18, 1886. (United States Patent Office, Dec. 18, 1886.)

566 Johnson and Johnson:

No assignments found of record affecting this patent from Dec. 10,'86, up to and including Jan'y 17,'87.

T. R. S.

(2–187.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

Application of Lewis H. Nash, assignor to National Meter Company, for reissue of letters patent No. 211,582, dated January 21, 1879, for improvement in "rotary water meters."

I certify that the annexed is a true copy from the digest of assignments in this division of all assignments of undivided interest

found of record under or relating to the aforesaid letters patent up to and including December 10, 1886.

A. J. KELLEY,
Chief of Assignment Division.

[Endorsed:] (2–187.) Reissue. Certificate of title.

567 Assignors.	Assignees.	Date of assignment.	Date of record.	Invention.	Territory assigned.	Liber.	Page.
Lewis H. Nash.	National Meter Company of New York city.	Oct. 28, '78.	Nov. 8, '78.	Improvement in water meters. Case B. Specification executed Jan'y 21, '79. 211,582. Another patent.	His right, the patent to issue to the assignee.	L 23	106

[Endorsed:] 25381. D., '86.

568 Room 221.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec.* 29, 1886.
Mailed " 30, "

L. H. Nash, care Johnson & Johnson, present.

No. 222,012. Rotary water meter. Dec. 18, '86.

This reissue application has been taken up for examination. The drawings are not fully lettered. See pencil notes on the drawings. The fifth claim is refused on the English patent to Galloway, No. 11485, A. D. 1846, on the following grounds: Applicant asks for a reissue on the ground that his first claim in his original patent is answered by the patent to Galloway, but the fifth claim in the present application is distinguished from the original first claim only by the fact that the piston is of hard rubber; but charge of material does not imply invention, especially as rubber has been used before for pistons in water meters. See patent 150,611, Read, May 5, '74, rotary meters. If, therefore, original first claim is met, present fifth claim is also.

F. A. SEELY, *Ex.*

ELY, *Ass't.*

[Endorsed:] Serial No., 222,012. Paper No. 2. Rej. Dated Dec. 29, 1886.

569 IN THE UNITED STATES PATENT OFFICE.

In Re LEWIS HALLOCK NASH.

Rotary water meter. Filed Dec. 18, 1886. Serial No., 222,012. Reissue.

WASHINGTON, *Jan.* 11, 1887.

The Commissioner of Patents.

SIR: In the above-entitled matter please make the following amendments, viz:

Erase clauses 2 and 5 of the claim and insert the following, viz:

"2. A piston for water meters, pumps, and motors, having alternate bearing points or projections and recesses, adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking motion within and upon continually changing lines across the center of said chamber, to effect its division
A. at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, combined with a top and bottom end plate in said cylinder chamber, and with means, substantially as described, by which the water is caused to flow over both ends of said piston.

5. A piston for water meters, pumps, and motors, having alternate bearing points or projections and recesses, adapted,
A[1]. by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking motion within and upon continually changing lines across the center of said chamber, to effect its division
570 at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, said piston being formed of hard rubber and having a free movement within said cylinder, controlled by the shape of the piston, the shape of the cylinder, and the flow of water through the meter."

The drawings have been properly lettered.

A reconsideration of clause 5 of the claim is respectfully requested.

Referring to this claim, it is respectfully suggested that the subject-matter thereof is not met in the Read patent nor in the English patent of Galloway.

Very respectfully, JOHNSON AND JOHNSON,
Attorneys for Lewis H. Nash.

[Endorsed:] Serial No., 222,012. Paper No. 3. Amendment A. Filed Jan. 11, 1887. Mr. Examiner Seely. *In re* L. H. Nash. Reissue. Amendment. U. S. Patent Office, division XXIII, Jan. 11, 1887.

571 (2-031.)

Issue division. 222,012.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., *Jan:* 21*st*, 1887.

Lewis Hallock Nash, ass'or, c. o. Johnson & Johnson, city.

SIR: Your application for reissue of patent No. 211,582, for improvement in rotary water meter has been examined and allowed.

The patent will be forwarded to you as soon as practicable in due order of business.

Very respectfully, M. V. MONTGOMERY,
Commissioner of Patents.

572 1886.

Serial No., 222,012. Ex'r Book No. $\frac{167}{7735}$.

Reissue No. 10806. Seely.

Lewis Hallock Nash,
Ass'or to the National Meter Company of New York City,
Of Brooklyn,
County of ——,
State of New York.
Invention, rotary water meters.

Parts of application filed.
- Petition, Dec. 18, 1886.
- Affidavit, " " "
- Specification, " " "
- Drawing, 5 sh., " " "
- Old patent, " " "
- Abstract of title, " " "
- Cert. deposit, ——.

1. Cash, $30, Dec. 18, 1886.
2. App. filed complete Dec. 18, 1886.
No. and date of original patent, 211,582.
3. January 21, 1879.
Examined Jan'y 19, '87. F. A. Seely.
Countersigned: Jan. 21, '87. T. W. Dick Bullock, for Commissioner.
Notice of allowance, Jan. 21st, 1887.
Reissued Feb'y 8, 1887.
Att'y or P. O. address, Johnson & Johnson, city.

573 Class —.

1886. P.*

Contents.

½. Application, 1 papers.
1. Dec. 18, '86, abst. of title & original patent.
2. Dec. 29, '86, rej.
3. Amendment A, Jan. 11, 1887.
4.
5.
6.
7.
8.
9.
10.
11. 78. Measuring instruments.
12. Rotary meters.*
13. Rotary meters.
14.
15.
16.
17.
18.
19.
20.

Title:
Improvement in rotary water meter.

Ex'd:
E. L. Layne.
M. F. Moore.

[Endorsed:] 10751. D., '88. I. 4398. U. S. circuit court. Filed Sep. 21, 1888. John A. Shields, clerk. 21. p'd, 9, 21, '88.

Endorsed on cover: Case No. 13,784. S. New York C. C. U. S. No. 192. The National Meter Company, appellant, *vs.* The Board of Water Commissioners of the City of Yonkers. Filed October 16, 1889.

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*In pencil in copy.

149 U.S. 548

Office Supreme Court U.
FILED.
MAR 29 1893
JAMES H. McKENNEY,
CLERK.

CASE No. 13,784.

Supreme Court of the United States.

OCTOBER TERM, 1892. TERM NO. 192.

THE NATIONAL METER COMPANY,

Appellants,

vs.

THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS,

Appellees.

ARGUMENT OF COUNSEL FOR APPELLANTS.

EDMUND WETMORE,
J. EDGAR BULL,
Of Counsel.

BROADNAX & BULL,
Solicitors.

The Evening Post Job Printing House, New York.

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Case No. 13,744.

Supreme Court of the United States.

TERM NO. 192.—OCT. TERM, 1892.

NATIONAL METER COMPANY,
Appellants,

vs.

THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS,
Appellees.

Argument of Counsel for Appellants.

This action was brought on the equity side of the United States Circuit Court for the Southern District of New York to restrain the infringement of Reissued Letters Patent No. 10,806, granted February 8, 1887, to the National Meter Company, assignee of L. H. Nash, for improvements in rotary water meters.

The bill is in the ordinary form, and prays for an injunction and an accounting. It was dismissed in the Court below on the ground of non-infringement.

The defenses relied upon are non-infringement and invalidity of the reissue.

Infringing Device.

The meter which we allege is an infringement of the patent in suit was manufactured by the Hersey Meter Company. It is known to the trade as the "Hersey Meter," and is manufactured under Letters Patent granted to James A. Tilden, superintendent of the Hersey Meter Company (Record, p. 14).

The Hersey Meter Company are the real parties defendant in interest.

Although the Board of Water Commissioners of Yonkers are the nominal parties defendant, the real parties in interest are the Hersey Meter Company. Their counsel on the record admitted that (Record, p. 14):

"The conduct of the defense in this cause is under the direct control of said Hersey Meter Company, and is being conducted by counsel of their own choice and in their employ, and the expenses thereof are being and will be borne solely by them."

PART I.

BRIEF OUTLINE OF CASE.

BRIEF OUTLINE OF CASE.

Water Meters.

The patent in suit relates to water meters. Such meters are placed on service mains in stores, factories, public buildings, &c., and in private dwellings to measure water, just as gas meters are used to measure gas. Anything will measure water that can be filled and emptied. The piston and cylinder of any steam engine (either reciprocating or rotary) will measure water if there be attached to the piston a register to indicate the number of times the cylinder has been filled and emptied. There is, therefore, an analogy between steam engines and water meters, and this analogy has been long recognized by engineers, and is admitted in the patent in suit.

State of the Art.

In the year 1846 an Englishman by the name of Galloway obtained a patent in Great Britain for a rotary steam engine in which the receiving and discharging spaces were formed by a piston having projections traveling around in a cylinder having the same number of projections, with an orbit motion—that is, a motion of revolution around the centre of the case—substantially as the moon revolves around the earth. In so doing the piston divided the space within the cylinder into enlarging and contracting spaces. The piston of this engine did not revolve on its axis. This is known in the case as the *Galloway Patented Engine.*

About the same time this same man, Galloway, devised a 300 H.-P. steam engine like his patented engine in all respects, except that the piston had one less point than its case, and, therefore, rotated on its axis as it revolved around the centre of the case with an orbit motion, just as the earth revolves about its own axis at the same time that it revolves

around the sun. This engine is described in Defendants' Exhibit Rouleaux's Kinematics of Machinery and is known in the case as the *Galloway Kinematic Engine.*

The difference between these two types is purely formal and incidental, as the revolution of the piston in the Galloway Kinematic Engine on its axis has nothing to do with its functions as a piston, the formation of receiving and discharging spaces being entirely due to its orbit motion, just as the elliptical orbit motion of the earth and moon is the agency by which one is kept from falling into the sun and the other from falling upon the earth, while the rotation of the earth on its axis is purely formal and incidental as far as this function is concerned. A claim properly drawn on the Galloway Kinematic Engine would have been infringed by his Patented Engine, just as a claim properly drawn on the earth would be infringed by the moon.

How Water Meters and Engines differ.

But the requirements and conditions of work in engines and meters are so widely different that no steam engine would make a practical or commercial water meter of the slightest value without radical changes. The reasons are obvious. The object of an engine is to use up all the pressure of the steam passing through it, so that the pressure at the exhaust shall be *nil;* while the object of a meter is to use as little of the pressure of the water as possible, so that the pressure at the exhaust shall be *maximum.* It is permissible in an engine to use complicated parts and parts requiring lubrication and constant attention, while in a water meter complicated parts or parts requiring either lubrication or attention cannot be employed. Steam, the fluid which passes through an engine, is one of the most elastic substances known and is very light; while water, the fluid passing through a meter, is the most

inelastic of known substances and is comparatively heavy. Due to these differences, and others which might be mentioned, it has been proved that the best type of structure for a water meter is one which is absolutely useless in steam engineering. To convert a steam engine into a commercially successful water meter, therefore, furnishes a broad field for invention, and in this field a vast amount of capital, persistent thought, time and labor have been expended.

These Galloway structures had no practical importance in the art until modified and adapted for use as a water meter by Nash. Indeed, a practical or useful rotary engine has never yet been made. The best is nothing more than a scientific toy. Yet in no other branch of engineering has so much capital and labor been spent as in this. At the time when Galloway constructed his engines a rotary engine was considered the great desideratum and every resource of the times was used to make these devices a success. Endless varieties were designed. The English admiralty gave their assistance and vessels were constructed to try them; but in spite of all they were absolute failures and for many years nothing of importance had been done with them.

Prior to Nash's invention, many water meters on the plan of reciprocating engines, turbine wheels, double piston rotaries, and the like, had been made and patented, and were in use; but no one had ever made a water meter on the plan of a single piston rotary engine, of which the Galloway may stand as a type.

Such was the state of the art when Nash made the invention of the patent sued on.

Nash obtained a Patent on the Galloway Engines.

Neither Nash nor the Patent Office at this time knew of the existence of either of the Galloway engines, and they supposed that to Nash, and not to Galloway, belonged the credit of first inventing this

particular type of rotary displacement structure. He was, therefore, granted a broad patent, the first claim of which was for a "water meter, pump or motor" (engine) in which there was a piston having projections revolving with an orbit motion in a case having projections in such a way as to form receiving and discharging spaces communicating with suitable ports. The piston rotated on its axis as did the piston of the Galloway Kinematic Engine, but as the revolution of the piston on its axis was a feature which did not effect its operation in any way, the first claim was very properly not limited to the relative number of projections on the piston and cylinder, or to the rotation of the piston on its axis.

Nash's Discovery.

What Nash did, in part, was to discover and demonstrate that these rotary devices, useless as steam engines, nevertheless had great usefulness in the art as water meters, if properly modified and adapted. Nash was the first to put to a practical use a single piston rotary device. That type of meter is now admitted to be beyond comparison the best. More than ninety per cent. of the meters sold to-day are of this type.

The particular form of rotary to which he added the improvements which converted it into a successful water meter was the Galloway.

Nash's Invention.

But aside from this, and beyond it, the meter which Nash invented contained other novel features which had never before been introduced in either a water meter, pump or engine of any description, and which are now universally recognized as the key to the solution of the problem of making a practically perfect meter, a problem so difficult that the combined ingenuity of hundreds of engineers in this

country and abroad had only succeeded up to this time in shrouding the subject in a "kind of mys-"tery and in producing the common impression "that a successful meter was about as unattainable "as perpetual motion" (Tilden Article, Record, p. 80). These features are admitted even by Mr. Tilden to constitute "a step of great importance in the art," and the Nash meter has been substantially acknowledged to be "the meter ultimatum" (Record, p. 83).

This is one of those cases, very scarce nowadays, in which even defendants' expert admits that the invention of the patent sued on is not within the expected skill of the calling; that it is, indeed, both meritorious and valuable. The fact is, Nash struck out on an entirely new line. He overcame known difficulties in a way that had never occurred to any one before. His conception was masterly, and the structure in which it was embodied was so perfect that it has not in any material respect been improved on since.

Every engineer before Nash had tried to make his meter accurate by close fitting or the use of packing. Nash saw that success did not lie in that direction, for close-fitting means increased friction and wear. He conceived a plan by which the very looseness of fit should not only increase the life of the meter, but *should increase its accuracy.*

He made a meter that is in good condition when it is worn out.

To appreciate the invention of Nash, it is only necessary to consider the paper read by Tilden, the inventor of the infringing device, before the Boston Association of Engineers November 17, 1886 (Record, p. 79).

The problem solved by Nash was one which Mr. Justice Blatchford in *Consolidated Valve Co.* vs. *Crosby Valve Co.* (113 U. S., 157), has happily termed "the reconciliation of antagonisms."

Water passing through a meter has two paths open to it: (1) It can pass through the meter chambers and be measured, but to do this it must move the piston; or (2) it can leak around the piston and thus pass through without being measured.

Everybody before Nash tried to compel all the water to go through the measuring chambers by tight fitting or by the use of packing, as is done in steam engineering. But as lubricants cannot be used excessive friction was the result, which caused corresponding wear and diminished the "head" of the water passing through it.

Nash reversed all this. Since water divides itself between two paths in the inverse ratio of their resistances, decreasing the resisttance in one path is equivalent to increasing it in the other. Instead of increasing the resistance around the piston by fitting it closer, Nash relatively increased it by decreasing the resistance which the water overcame in moving the piston. *He made the looseness of fit which had been the very cause of leakage before an element in preventing leakage.*

That this was a "step of great importance in the art" and that the step involved the exercise of rare inventive ingenuity, no one, as far as we know, has ever had the temerity to doubt.

And this is how he did it:

Every engine, pump or meter before the patent in suit had its piston controlled by journals and bearings and had to carry or operate separate valve mechanism to open and shut the ports leading to and from the enlarging and contracting chambers.

Nash was the first to make a piston that had neither journals nor bearings. This feature is covered by claim 4 of the patent in suit.

Nash was the first to make such a piston without journals and bearings of a material nearly the same specific gravity as water. In other words, he was the first to make a piston which would float (like a

chip) in the stream, uncontrolled in any way other than by the water flowing through the meter. This feature is covered by the fifth claim of the patent in suit.

Nash was the first to make an engine, pump or meter in which the piston was its own valve, thus relieving it of the work of carrying or operating separate valve mechanism. This feature is covered by the sixth claim of the patent in suit.

Nash was the first to make an engine, pump or meter in which the piston had internal water passages which, in connection with ports in the case, conferred upon the piston the capacity of functioning at its own valve, without increasing either the size (or weight) of the piston. This feature is covered by the third claim of the patent in suit.

All these features have a common object in view, to wit: To decrease the weight and friction of the piston, and thereby to decrease the resistance which the waters meet in moving it, *and thereby to relatively increase the resistance encountered by the water in leaking around the piston*.

All of them together make a piston so sensitive that it is literally easier for the water to move it than for the water to squeeze past it, even when it is loosely fitted.

And it is here that we have a seeming paradox. By fitting the piston loosely friction is still further decreased and the resistance which water meets trying to squeeze past is relatively increased.

The pistons of both complainant's and defendants' meters were shown by test to be so loosely fitted that when blocked the meters passed nearly *one-third* the amount of water that could be passed when the pistons were operating.

The pistons are fitted so loosely that there is constantly a film of water between the piston and the head-plates. Water is an excellent lubricant for hard rubber. The pistons literally float in the

stream without coming in contact with either head-plate and being entirely unrestrained, unhampered by journals or bearing, relieved of the work of operating valves, made of a material nearly the specific gravity of water, it is actually easier for the water to move the piston than it is to squeeze past it, loosely fitted as it is. Such a meter, if no accident befall it, will last almost indefinitely, and the head of water to the consumer will not be materially affected by its presence.

Official tests show phenomenal accuracy and durability. See Exhibits F, G, H, I, J (Record, pp. 85 to 91).

These Exhibits F, G, H, I and J, show the results of official tests made by various water departments in different cities of "Crown" meters, selected at random, that had been in long continued use without repairs. None of the meters tested had measured less than *fifty thousand* cubic feet of water and some had measured ten times that amount; yet when tested on streams as small as one-sixteenth of an inch (which is smaller than the lead of an ordinary pencil) they proved, almost without exception, to be uninjured by service and still capable of literally measuring water in drops. The results are the more remarkable when it is considered that these meters had been in continuous use in cellars for years—some of them more than seven years—without being moved or even opened. Probably there is not another automatic machine in existence that would show such results, and, as Tilden in his paper read before the Boston Society of Civil Engineers said, water meters receive "abuse rather than use" (Record, p. 80).

Commercial Value of Nash's Invention.

These meters, under the trade-name of "Crown," were first put upon the market in the year 1878, and although the highest priced meter on the market,

they met from the start with phenomenal success and completely revolutionized the meter art, not only in this country but abroad. In June, 1888, when the testimony in this case was taken, more than 51,000 were in actual use in the United States alone, distributed through 470 cities and towns; and to day more than double that number are in use. The meter having the next largest sale has been on the market more than three times as long as the Crown, and for two-thirds of that time has had the field practically to itself, and yet its aggregate sales do not nearly equal the sales of the Crown.

What Tilden did.

Mr. Tilden, the inventor of defendant's meter, admits that at about this time he made several attempts to invent a successful water meter and failed. After the commercial value of the Crown had been fully demonstrated, *Tilden took the Galloway Patented Engine, and added to it each and every one of the improvements that Nash had previously added to the Galloway Kinematic Engine*, thereby making a meter which was like the Crown in every respect except that the piston did not rotate on its own axis. This meter is known to the trade as the "Hersey" meter, was put on the market in 1885 or 1886, and is the infringing device.

What Nash did and what Tilden copied may be summarized in brief as follows:

(1.) The "Crown" had a piston which moved about within its case without journals or bearings. Tilden took the Galloway Patented Engine and applied to it this feature.

(2.) The "Crown" had the head plates of the cylinder chamber fixed and between them the piston, without journals or bearings, moved. Tilden copied this feature.

(3.) The "Crown" had a piston made of hard rubber so that it would float in the current. Tilden copied this feature.

(4.) The "Crown" had the piston itself act as the valve to control the flow of water into and out of the measuring spaces. Tilden copied this feature,

(5.) The "Crown" had the separate inlet and exhaust ports placed in the stationary head plates and had a large central port in the piston, which ports co-operated to confer upon the piston the function of acting as its own valve. Tilden copied this feature.

(6.) The "Crown" was arranged so that the water would enter at the bottom and leave at the top. Tilden copied this feature.

(7.) The "Crown" had a piston which was balanced, that is, the water was received and was discharged in such a way as to make the pressure on both ends thereof substantially equal, so that the piston was held in suspension by the water between its end plates without rubbing against either of them. Tilden copied this feature.

(8.) The "Crown" had a piston so loosely fitted between the head plates that a large percentage of the water would leak through were it not for the fact that it prefers to move the piston rather than to leak around it. Tilden copied this feature.

As far as the mechanical construction of defendant's meter is concerned, even down to its every details, all was taken by Tilden directly from the "Crown" meter. All this he had done at the time he applied for his original patent, dated August 18, 1885. But at that time the case in which he inclosed the working part of his meter did not at all resemble the case of the "Crown" meter. He did not stop here.

(9.) The "Crown" meter had an external inclosing case which formed, in connection with the case proper of the meter, a portion of the outlet passage. Tilden copied this feature.

Tilden has even gone so far as to discard the case shown in his patent and to put his meter in an external case which in color and outline so nearly resembles the case of the "Crown" meter that ordinary observers, giving such attention as purchasers ordinarily give, would not detect the difference.

There could be no object in thus copying the "Crown" case except to deceive the public.

Tilden obtained a patent on his meter after the application for it had been amended to avoid the Crown patents, and as the existence of neither of the Galloway engines was as yet known to the Examiners in Patent Office, he obtained a claim broad enough to cover the Galloway Patented Engine as distinguished from the Galloway Kinematic Engine.

Defendants Notified of Infringement.

As soon as complainants saw the "Hersey" meter (and before it was sold) they informed the Hersey Meter Company that their meter infringed the Nash patent, and if it were put on the market they would sue them for infringement.

Why Nash's Patent was Reissued.

In November, 1886, complainants engaged counsel to commence suit against the Hersey Company and laid before them the Nash patent, the infringing meter and the Galloway 1846 British patent, which was first brought to the attention of the owners of the Nash patent in September or October, 1886, although it appears that Nash (who had parted with all interest in the patent in 1879) knew of its existence nearly a year earlier.

The counsel whom they retained advised them that, in their opinion, the Hersey meter infringed the first claim of the Nash patent, which was not limited to a piston rotating on its centre; but that this claim was bad because anticipated by the British patent on the Galloway Patented Engine.

Pursuant to the advice of counsel the Nash patent was then reissued and the broad claim limited to those features by which Nash had converted the useless Galloway engine into an efficient water meter. In reissuing this patent neither the specifications nor drawings were changed in the smallest particular. At the end of the specifications a disclaimer in view of Galloway was added in the words of original claim 1, and in place of original claim 1 six new claims were substituted, each one containing word-for-word the whole of original claim 1 with the addition of an element or elements not found in the original claim. This reissue is the patent in suit.

In November, 1886, Tilden also reissued and limited his patent in view of Galloway.

Infringement of Claim 1 *of Nash Original Patent.*

Defendants cannot infringe the reissued patent unless they infringed the original. In dealing with the question of infringement, therefore, we shall inquire, first, whether defendants' meter infringed Nash's original claim 1; and having determined that point we shall proceed to determine whether it infringes the 3d, 4th, 5th and 6th claims of the reissue, which are the only claims of which infringement is charged.

There is no dispute but that defendants' meter contains four out of the five elements composing this original first claim. Concerning the third element, which requires that the piston shall have an "*eccentric or side-rocking*" motion, there is dispute;

and upon the meaning of this term the question of infringement hinges.

Defendants banish the word "eccentric" from consideration, and contend that as there is a motion in some of the Nash structures which they think *ought* to have been called "side-rocking," that this is the true definition of the term employed in the claim.

We reply that defendants' definition must be rejected because it is not derived from the patent and flatly contradicts its terms, and because it does not include the motion of Figs. 10 and 11 of the patent, which the specifications in terms say *do* side-rock.

We say that what the term "eccentric or side-rocking" means must be ascertained from the patent itself. Our definition is taken directly from the specifications which uniformly employ the term to describe the *orbit* motion of the piston as distinguished from rotation on its axis (just as the word "elliptic" describes the orbit motion of the earth as distinguished from its diurnal motion). We contend that this uniform use of the term in the specifications finally determines its meaning in the claims, whether the term be happily chosen or not. The orbit motion of defendants' piston being identically the same as the orbit motion of the pistons of Figs. 10 and 11 of the Nash patent drawings, we contend that their meter is an infringing device.

While it is true that all the pistons shown in the Nash patent rotate on their own axis, just as the earth rotates on its axis, yet there is no warrant for limiting the claims by implication to this feature if it is purely formal and incidental and does not effect either the principle or operation of the piston.

To prove that the rotation of pistons of this type is purely incidental, we have, among other things, put the piston of defendants' meter into a case in which, while preserving its orbit motion, it is given

a motion of rotation on its axis, and we find that in this case it forms receiving and discharging spaces precisely like those formed by it in its own case where it does not rotate; that it controls precisely the same ports in precisely the same way; and that it works the registering mechanism in precisely the same way. These three functions are the only ones possessed by the piston, and we submit that this is a demonstration of the proposition that the rotation of these pistons on their axes is purely formal and incidental—just as the existence of the moon without rotation is a demonstration of the fact that for keeping its place in the solar system the rotation of the earth on its axis is incidental. We are confident that the Court will not read by implication into the claim a feature which is purely incidental and, therefore, was properly omitted from it.

Infringement of Claims 3, 4, 5 *and* 6 *of Nash Reissue.*

Having disposed of the question whether defendant's meter infringed claim one of Nash original patent, we will proceed to examine the narrower claims of the reissue. These claims defendants do not pretend are anticipated by anything contained in the prior art, and we may almost say that it is obvious without argument that they are flagrantly infringed.

As the reissue had no other purpose or effect than to limit the original, and as no one can infringe the reissue who did not infringe the original, the reissue under the principles laid down in a long line of cases in this Court is believed to be valid, although applied for more than seven years after the date of the original patent on which it is founded.

Such is in brief an outline of the prior state of the art, a history of the facts out of which this litigation grew, and a statement of the principal points at reissue between the parties.

PART II.

I.—STATE OF THE ART AS TO METERS:

(*a.*) *Displacement meters.*
(*b.*) *Rotary impact meters.*
(*c.*) *Rotary displacement meters.*

II.—AS TO ENGINES:

(*a.*) *Galloway patented engine.*
(*b.*) *Galloway Kinematic engine.*

III.—ANALOGY BETWEEN ENGINES AND METERS.

IV.—NASH'S CONTRIBUTION TO THE ART:

(*a.*) *Commercial success of Crown meter.*
(*b.*) *What Nash did in legal contemplation.*
(*c.*) *State of art not known to Nash or Patent Office.*
(*d.*) *Discussion of Patent drawings.*

V.—DEFENDANTS' METER:

(*a.*) *Designed after success of Crown was demonstrated.*
(*b.*) *Defendants' meter examined.*

VI.—COMPLAINANTS' AND DEFENDANTS' METERS COMPARED.

I.

General Survey of the Art Relating to Water Meters.

A great many types of meters have been designed, but whether employed to measure gas or a denser fluid, like water, they operate on substantially the same general principles, which may be easily explained and are readily comprehended.

(*a.*) *Displacement Meters.*

Suppose we have an ordinary cylinder and a piston fitted into it. The piston starts from one end of the cylinder while the water flows in behind it, filling the space to its full capacity. When the piston is drawn back again the water in the cylinder is expelled. This piston divides the cylinder into two chambers, one of which is enlarging while the other is contracting. If we know the capacity of the cylinder and have some device for indicating the number of times that the piston has made a complete stroke, it is evident that the amount of water which has passed through the device may be ascertained by multiplying the capacity of the cylinder by the number of times it has filled and emptied.

The movement of the piston causes each chamber first to enlarge until it reaches its maximum capacity and then to contract until it reaches its minimum capacity. The valves must be arranged so that water can flow into, but not out of, a chamber while it is enlarging, and so that it can flow out of, but not into, a chamber while it is contracting.

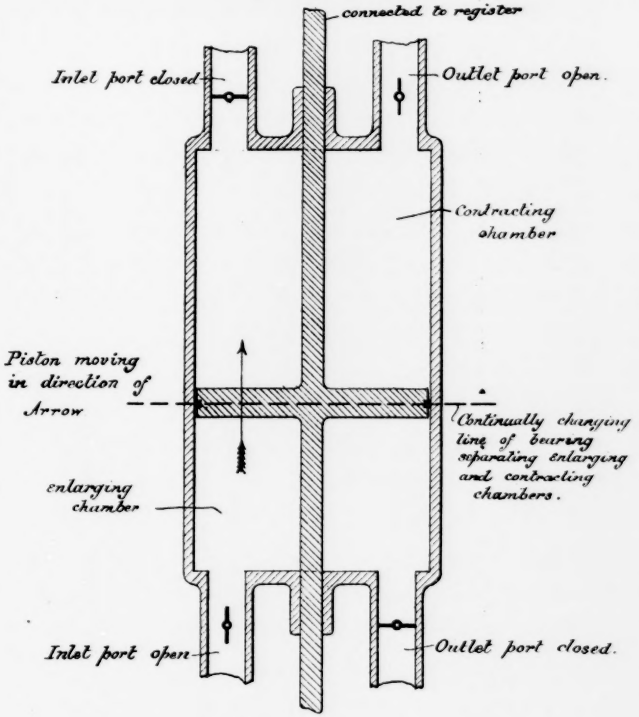
This is an illustration of the simplest form of metering device which operates by displacing action. It is plain that it may be employed to measure any fluid, either gaseous or liquid. (See Plate I.)

Now, this is precisely the operation of the piston and cylinder of an ordinary steam engine. Meters and steam engines are, therefore, to this extent analogous structures. Yet the piston and cylinder of an ordinary steam engine would not make in any sense a practical water meter. The conditions under which they work and the requirements of work are obviously quite different, as we shall hereafter more particularly point out.

We have seen that the volume of water passing through such a device may be accurately determined by multiplying the contents of the cylinder by the number of times it has filled and emptied. But the cylinder must have an end, and so must the stroke of the piston. At some point the piston must stop, and if we are to register the number of strokes, it must always stop at the same place. Here rests the first difficulty. Since the piston must come to a dead stop, it must be brought to rest without injury to the device. Consequently we cannot have a rapidly-moving piston when water, which is a practically non-elastic fluid, is passing through the cylinder. Again, our piston having reached the end of its stroke, the flow of the water must be changed in direction and therefore a continuous flow of the water, which it is desirable to have through a water meter, cannot be obtained in the simple structure we have described. Various devices have been employed to overcome this difficulty, such as by increasing the number of the pistons, or by almost instantly reversing the valve.

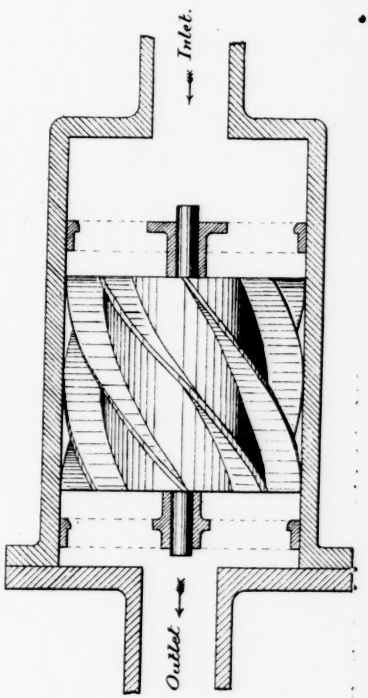
It is therefore apparent that while a reciprocating piston effects a positive displacement of the water, and in its simplest form is absolutely accurate, yet it has serious disadvantages, and is open to obvious objections.

PLATE I



Argumentative drawing illustrating the principle of operation of the simplest form of displacement meter.

PLATE II



Argumentative drawing illustrating the principle of operation of rotary impact meters.

(*b.*) *Rotary Impact Meters.*

For the purpose of obtaining a continuous flow and avoiding the necessity for valves and other complicated parts, rotary meters, of what is known as the "screw-wheel" type, have been used, and these operate by the impact of the water, as distinguished from its displacing action. These meters are like an ordinary propeller screw, the passage of the water turning the screw, instead of the revolution of the screw imparting motion to the water. Such a meter is illustrated in the patent to Reed of record and in Plate II.

While these are free from the objections above pointed out, and do not interfere with the flow, nor involve complicated mechanism, yet they are not accurate enough for ordinary purposes, and indicate only approximately the amount of water passed.

Merits of Displacement and Rotary Impact Meters Compared.

It is obvious that a meter to be accurate must work by the displacing action of the water, as in a piston and cylinder. It is equally obvious that a meter in which the piston has a continuous motion, as distinguished from a motion of vibration, possesses great advantages. To reduce a meter to the size required by a marketable price, the working parts must move with great rapidity. That is to say, if it is desired that a very small part do the work of a large one, it must, of course, move very fast. This means the use of a revolving piston in preference to a reciprocating piston. It is obviously impossible for a reciprocating piston to attain the speed in a non-elastic fluid that a continuous motion or revolving piston is able to reach.

(c.) *Rotary Displacement Meters.*

Mr. Tilden, manager of the Hersey Meter Co., and patentee of the infringing meter, read a paper on water meters before the Association of Engineers, November 17, 1886, which was published in the *Engineering News.* (See Exhibit Tilden Article, Record, p. 79.) Among other things, Tilden there says:

"A positive displacement rotary, in distinction from the turbine or screw-wheel type, has constantly been sought for as the solution of an efficient, low-priced meter. The same observation applies here as in the reciprocating piston. Almost any reasonable, well constructed rotary piston will measure water if not overcrowded; but with few exceptions they would have to be made so large as to be unavailable, or if reduced in size, are sure to introduce the same defects as noted in the reciprocating meter. *Friction and consequent wear and inaccuracy has been an almost unsurmountable obstacle in the path of a small piston rotary.*"

Difficulties to be Overcome in Constructing a Successful Water Meter.

But the capacity for accurately measuring the fluid passing through it is not the only requisite for a successful water meter. Indeed, the difficulties of the problem are so great that, as Mr. Tilden points out in his article, the common impression exists that "a successful water meter is about as unattainable as perpetual motion."

This article written by Mr. Tilden describes many of the requisites of a successful water meter and some of the difficulties to be oveecome in constructing one.

He says (Record, p. 80):

"To be efficient, a water meter must be accurate within a permissible error, under extremes of pressure and rates of flow, of perhaps two per cent. in

favor of either department or consumer, and must maintain this standard with a reasonable *or rather an unreasonable* degree of permanency. It must not materially or noticeably retard the flow or diminish the pressure, and should be able to pass, without stopping, clogging or breakage, substances often carried along with the water, such as sand, sediment, pipe scale, &c. It must be able to withstand, without damage, water hammer caused by sudden closings, and in itself produce none, or make any noise from its working parts. Altogether, it must be compact, of non-corrosive material, inexpensive in repairs and capable of standing *abuse rather than use.*" * * *

"Efficient and cheap it must be in order to meet a demand which does not exist for a high priced machine. It is the cost at which it must be produced which makes its duty and requirements in *excess of almost any other automatic machine.*"

"It may be noted here that in a comparison of economy of meters, durability and permanency are as great a factor as price." * * *

"In order to come within the narrow limits of price, many attempts toward a reduction of size and weight have followed, and as a result some of the special requirements of a meter have been sacrificed. As an instance, in the attempt to make a single piston do the work of two an infinite variety of valve mechanisms have been devised with a view of obtaining the same easy movements found in the best double-piston meters. The uniform results have been that either the single piston meter must be made large enough to equal in capacity the double piston, or one of the following defects would ensue:"

"FIRST.—A mechanical noise caused by the striking of the moving parts, such as would come of the use of levers, weights or springs in obtaining a reverse movement of the piston or in the use of a supplemental valve, by the main or auxiliary piston striking its bunters.

"SECOND.—Water hammer caused by the checking of the flow at the instant of reversal of the main valve; or, third, if this is avoided by the use of puppet or open, slide or piston valves, annoying inaccuracy of registering ensues from the varying loss of water under different conditions at the time the valve is changing." * * *

"In the attempt to meet this cost feature by a diminution of size, overwork of one or more parts or a general overcrowding is the general result, causing either rapid wear or some of the immediate annoying defects, such as mechanical noise, water hammer, stopping, small capacity, inaccurate or uneven registration, &c." * * *

"The United States patents—class of meters—number, at this reading, 552; those of England and colonies nearly as many more, and the number is well approached by the sum of France, Germany, Belgium and others." * * * "While an enormous amount of money has been expended in experiments, the total number of patents probably represented but a part only, a small portion has been utilized in well executed designs, as shown by the the very few efficient devices in the market. If this statement is true *there must have been some special difficulty peculiar to the problem.*" * * *

II.

State of the Art as to Engines.

(*a.*) *Galloway Patented Engine.*

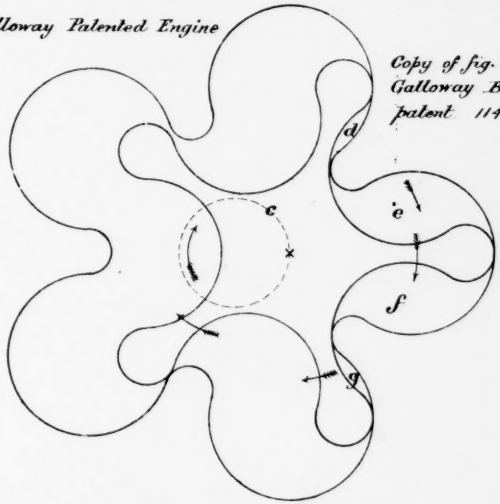
In the year 1846, Galloway obtained a patent in Great Britain for a rotary displacement steam engine (see Record, pp. 171 to 175; Galloway Patent No. 11485 of 1846). A reference to the drawings of that patent will show that the piston of the engine is provided with the points, and that the cylinder is also provided with points, the points on the piston and on the cylinder being equal in number. The piston moves around within its case with a circular orbit motion. It is always in contact with the case at several points or lines of contact, which, as the piston moves, form continually changing lines of division and thus divides the place within the cylinder into enlarging and contracting chambers, which are connected with suitable ports. This engine is known in the case as the Galloway Patented Engine.

PLATE III

The Galloway Patented Engine

Copy of fig. 2 of Galloway British patent 11485 '46

Fig. 1.



The Galloway Kinematic Engine

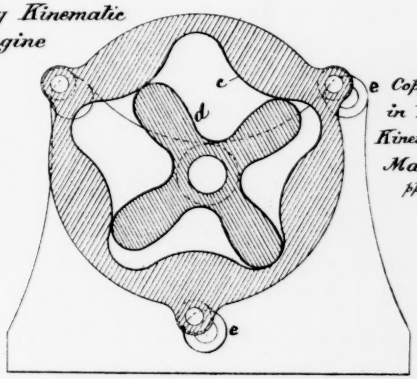


Fig. 2

Copy of figure in Reuleaux' Kinematics of Machinery pp. 434 & 435

Galloway Engines.

Galloway thus described the operation of the device (Record, p. 172). See Plate III.

* * * "if we insert a pin into the centre of the inner figures and describe therewith the dotted circle *c* (Fig. 2) beginning by placing the parts as shown at Fig. 2, we shall find that there will be several points of the two figures in contact with each other in every part of the movement produced by describing the circle *c*, and if the pieces be truly formed, several of the intermediate space, as *d*, *e*, *f* and *g* (caused by the contact of the segments) will be found successively to be enlarging and contracting during the movement of the inner piece. If we now conceive the pieces to be enclosed between flat surfaces fitting accurately, it will be seen that any fluid contained in cavity *d* could not get into cavity *e*, nor that in *f* into cavity *g*, and it will be found that in whatever part of the circle *c* the centre of the inner piece be placed, if it be pressed outwards, there will be several insulated cavities, like *d*, *e*, *f*, *g*. Now, let us suppose steam be admitted by some suitable arrangement so as to be entering into the cavities *e* and *g*, and that the cavities *d* and *f* have a passage open to the atmosphere, it would follow that the inner piece, which I shall henceforth call the piston, would have a tendency to move in the direction of the arrows (Fig. 2)."

(*b.*) *Galloway Kinematic Engine.*

Subsequently this same man Galloway designed a modified form of this engine, which is described in Reuleaux's Kinematics of Machinery (translated by Alexander B. Kennedy and published in 1876), in which there was likewise a piston provided with points, and a cylinder provided with points, the points on the piston being less in number than the points on the cylinder. This piston moved around within its case with a circular orbit motion, several points of the piston and case being always in contact and forming continually changing lines of division as the piston moved, thus dividing the space within the cylinder into enlarging and contracting

chambers connected with suitable ports—all as in the Galloway Patented Engine, except that in this Kinematic Engine the case has one more point than the piston, and the piston, therefore, had, in addition to its circular orbit motion, *a motion of revolution on its own axis*. This engine is known in the case as the Galloway Kinematic Engine.

Reuleaux says (see Defendants' Exhibit Reuleaux Kinematic of Machinery, pp. 435 and 436) that Galloway designed a 300 H.-P. marine engine on this plan, and describing the figures illustrating it, says (see Plate III.):

"The figures show distinctly enough that the space between the teeth *c* and *d* varies periodically from the maximum to the minimum, and is therefore suitable for use with a pressure organ (steam or water), which can be alternately admitted to and discharged from it."

Points of Similarity between Galloway Patented and Kinematic Engines.

It will be observed that in both these engines the piston has projections, the case has projections, and the enlarging and contracting chambers are formed by the piston always being in contact with its case at two or more points. In both the *orbit* motion is precisely the same—it is circular. The only difference between the two types is that the piston of one rotates on its own axis while it pursues its orbit about the centre of the case, and the piston of the other does not rotate on its axis. It is simply the difference between the motions of the earth and the moon, both of which have the same orbit motion, but only one of which (the earth) rotates on its axis. We shall show (*infra*, p. 67) that this difference is purely formal; that the measuring spaces are formed solely by the orbit motion of the piston in both cases, and that the revolution of the piston on its

axis in the Kinematic Engine has nothing to do with its operation—just as we know that it is the orbit motions of the earth and moon that keep these bodies in their respective places in the solar system, and that the revolution of the earth on its own axis has nothing whatever to do with this, and is, in this connection, incidental purely.

III.

The Analogy between Engines and Meters examined.

We have already seen that the cylinder and piston of a steam engine form an accurate device for measuring the quantity of water which passes. Steam engines and water meters are, therefore, analogous structures to this extent.

But the capacity of accurately measuring or metering water is not the only essential requirement of a practical water meter. If it were, such tilting boxes as are employed in observatories to register rainfall, which are suspended so that when they have received a given quantity of water they automatically tip, empty and right themselves again, would be, on account of simplicity and effectiveness of design, the perfection of a meter. Of these Mr. Tilden in his article says (Record, p. 83):

"Of course they are entirely unavailable for the market, as the introduction of a meter on a pipe must not reduce or affect the pressure."

The different conditions under which a steam engine and a water meter work, and the different functions performed by them, broadly distinguish the two and leave an ample field for the exercise of inventive ingenuity. If this were not true the best type of device for steam engines would be the best type

for water meters; and the poorest type for steam engines would be the poorest type for water meters. But the best type of device for a water meter is one which is utterly valueless in steam engineering, although a vast amount of money has been spent to make it useful.

The reasons for this are obvious, because:

(1.) The object of a steam engine is to utilize and use up all the pressure or head of the steam, so that the pressure at the exhaust shall be *nil*.

The object of a meter is to perform its functions with the use of as little head as possible, so that the pressure at the exhaust shall be maximum. This consideration is of paramount importance, both to the water department and to the consumer. Loss of head compels the department to incur the expense of building and maintaining high reservoirs and of pumping the water into them, or the use of high stand pipes or similar contrivances, to supply the water. Or if this be not done, consumers are deprived of the use of water on the upper stories of buildings, or to resort to local tanks and the use of pumps.

(2.) Engines may be, and indeed always are, made with delicate, complicated and expensive parts, requiring lubrication and constant attention.

On the other hand, a meter must be cheap and must be accurate under the varying conditions of flow, whether a large or a small stream be passed, and it must maintain this accuracy without supervision and without the use of oil, which would taint the water. Indeed, to prevent the possibility of supervision or interference, meters are sealed up by the department, and must be sealed to prevent their being tampered with by the consumer. All inherent difficulties in their construction must be overcome without the use of such parts as are permissible and desirable in a steam engine.

(3.) Steam, the fluid which passes through an engine, is very highly elastic. The efficiency of an engine depends upon the degree to which the elasticity of the steam is utilized.

Water, the fluid which passes through a meter, is the least compressible of all known substances. It is this lack of elasticity in water which gives rise to the annoying "water hammer" to which Mr. Tilden refers in his article. To overcome this difficulty without destroying the accuracy of the meter or using complicated parts, is a problem which has sorely taxed the ingenuity of inventors, and has given rise to many ingenious but worthless contrivances.

Take, for instance, an ordinary cylinder and piston. While the chamber is enlarging by the forward motion of the piston, it must be open to the inlet, so that water can flow into it. While the chamber is contracting, it must be open to the outlet, so that water can flow out of it. The exhaust port should not be open until the chamber has reached its maximum capacity, otherwise water will flow through it without being registered; and if the device be working at its full capacity it should be wide open at the instant the chamber begins to contract. If it be not open wide enough to permit the water to flow out of the chamber as fast as the piston moves, the returning piston will strike the body of water which it cannot compress, and which cannot escape fast enough through the partially open port. This causes a concussion and a jar, and is what is known as the "water hammer."

This is entirely due to the incompressibility of water.

(4.) Steam, which acts upon the moving parts of an engine, is very light.

Water, which acts upon the moving parts of a meter, is heavy. The impact of the water due to its

weight, as distinguished from the displacement due to its bulk, plays a very important part in the operations of a water meter and enters as an important factor into the problem. The screw-wheel meters, of which that described in the patent to Read of record is a type, operate solely by the impact of the water and not at all by its displacing action, as is evident from the fact that the measuring chamber of such meters never contracts and enlarges, but always remains at a constant capacity.

These are not all of the difficulties which enter into the problem of designing an efficient water meter of substantially similiar type to a given steam engine, but they are the most obvious ones.

IV.

Nash's Contribution to the Art.

Such was the condition of the art at the time Mr. Nash, the inventor of the device covered by the patent in suit, conceived and patented the meter here in controversy. In the article from which quotations have been, Mr. Tilden, a rival inventor, and endeavoring to place upon the market a meter which would compete with, and supersede the "Crown," makes this significant statement in describing Nash's contribution to the art (Record, p. 83).

"*A step of great importance* has been taken in the combination of a casing and one piston in such a manner that the piston may move within its case *dependent upon no journals or bearings.* The effect of this is so far to reduce fricton and increase operative areas as to bring the meter within a very small compass. Were it not for one fault, one which is singularly developed as a special defect, the liability to stop by the wedging of a minute particle of sediment between one of the many contact surfaces offered

by their peculiar design, this meter would have proved the *meter ultimatum.*"

Mr. Tilden concludes his article with a description of defendant's meter, which he claims is better than the "Crown," because it can pass larger substances. He does not endeavor to conceal the fact that he has taken advantage of the "step of good importance" ascribed to Nash, or that he employs in his meter the improvements which have placed the "Crown" far in advance of its rivals. It appears from the proofs and from Tilden's own admission in subsequent patents, that his claim was without foundation. He did not even improve the meter of the patent in suit.

(*a.*). *Commercial success of complainants' meter.*

We do not need to rely upon the statements of the patentee of the infringing machine to prove the value of Nash's invention and the advance and practical revolution which it wrought in the art. Its phenomenal commercial success is the best possible evidence on this point. A very few of these "Crown" meters were sold in the latter part of the year 1878. From that time until this their sale has rapidly increased year by year until on June 1, 1888, when proofs in this case were taken, more than fifty one thousand were in actual use. Nine thousand were then in use in New York City and they were to be found in four hundred and seventy cities and towns in the United States alone. At the present time more than one hundred and nine thousand are in use in this country. They are also manufactured and extensively used in Europe (Kelley, Q. 5 to 9, Record, p. 29).

It is the intrinsic worth of the Crown meter that has given it an unexampled sale, as is evidenced by the fact that it is the most expensive meter

on the market (Kelley, Q. 14, Record, p. 30). The records marked Complainants' Exhibits F, G, H, I and J, show the remarkable durability and accuracy of this meter (Record, pp. 85 to 89).

Next to the "Crown," the meter which has had the largest sale is the "Worthington" (a reciprocating piston meter), which was put on the market about the year 1855, and has been continuously made and sold ever since. Yet in the thirty odd years this meter has been before the public (the greater portion of the time it practically had the field to itself) its total sales do not nearly equal the total sales of the "Crown" meter, which has been on the market less than one-third of the time (Kelly, Q. 12, Record, p. 30).

(b.) Nash's contribution to the art in view of what had previously been done and was known.

What Nash in legal contemplation really did was, first, to discover that the Galloway type of engine, which as an engine was wholly useless and was nothing more than a scientific toy (Brevoort, Record, pp. 17 and 48, Renleaux Kinematics, p. 435), possessed features that were of the greatest value in a water meter; and, second, to make certain improvements on this Galloway structure which converted it from a useless steam engine into a water meter of very great value. The improvements which he added to it had never been embodied in either water meters, pumps or engines of any description, and they are now universally recognized as the key to the solution of the problem of making a practically perfect rotary displacement water meter. These improvements are admitted to be important, and the contribution which Nash made to the art is acknowledged to be highly meritorious.

The particular type of Galloway engine in connection with which Nash described his inventions was

the Kinematic Engine, that is, the type which has one less point on the piston than on the case and which therefore rotates on its axis while it pursues its orbit motion around the centre of the case.

(*c.*) *State of art not known to Nash, nor to Patent Office.*

But Mr. Nash at the time that he took out his patent believed, as did the Examiners in the Patent office as well, that he and not Galloway was the first to make a rotary displacement structure in which there was a piston provided with projections and a case provided with projections, and in which the piston described an orbit motion about the centre of the case—and this irrespective of all other incidental motions which the piston might have. He was, therefore, granted a patent for "a water meter, pump or motor" (engine) having these characteristics. The first claim of his patent was not limited to a piston which rotated on its axis, as it properly should not have been, the motion of rotation being incidental and performing no function.

(*d.*) Discussion of Nash Patent Drawings.

Displacing Action of Nash's Pistons.

Complainants' Exhibit E roughly illustrates the combined action of the pistons and cylinders shown in the various figures of the patent in suit. On inspection it will be seen that in each of these devices there is a case provided with projections and that in each there is a piston also provided with projections. By sweeping these pistons around within their respective cases it will be seen that in each the recesses on the case co-operate with the projections on the piston, and constantly form two or more chambers which, as the piston moves, continually change their volume, enlarging and contracting.

These chambers, as they enlarge, must be open to the inlet, so that the fluid can flow into them; and when they have reached their maximum capacity and begin to contract, they must each be open to the outlet to permit the water to be discharged from them.

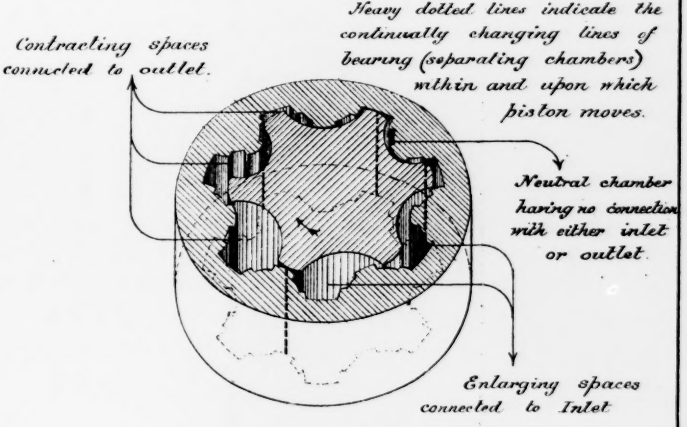
More than one continually changing line of contact necessary.

The measuring chambers are formed by the piston coming in contact with the case. In order that there shall be chambers, two or more points on the piston must at all times be in contact with the case. These points or, more properly, these vertical lines of contact or bearing, divide the space into chambers. If we move the piston around the centre of its case it will be seen that these points or lines of contact are constantly changing their positions. It is this constant change of position of these lines of contact which causes the chambers constantly to change their volume, some contracting while others are enlarging. The more points of bearing or lines of contact there be between the piston and cylinder, the more measuring chambers will be present at the same time. (See Plate IV.)

The several figures show pistons and cases of different forms. The form and relation of the measuring chambers depend upon the relative form of the pistons and cases. These figures, therefore, show measuring chambers of different forms. Every modification of the form of the piston and case necessarily introduces corresponding changes in the form and relation of the measuring spaces.

But the same essential characteristics exist in all, to wit, in each there is a piston having projections, and there is a cylinder having projections and the piston and the case meet at two or more continually changing points or lines of contact, and thus divide the space into a plurality of contracting and enlarging chambers.

PLATE IV.



Argumentative drawing of fig. 3 of Complainants' Patent.

Pistons are always Eccentric to Cases.

A further inspection of this model will show that in each figure of the patent drawings the piston stands eccentrically with relation to its case, and that as it moves in an orbit around the centre of its case it constantly maintains this eccentric relation. It is this eccentric position of the piston which brings the piston and case in contact on the lines separating the measuring chambers.

Receiving Spaces Distinguished from Discharging Spaces.

In these figures the receiving spaces may be easily distinguished from the discharging spaces if the operation of the piston and cylinder of an ordinary engine be constantly kept in mind. (See Plate I.) We have already seen with the ordinary piston and cylinder that the chamber which is increasing in size must be open to the inlet, so that water can enter and fill it, and that the chamber which is decreasing in size must be open to the outlet, so that water can be discharged from it. This is a universal rule applicable to all displacment mechanisms, whether they be water meters or steam-engines. Applying these principles to the models before us, any person can easily distinguish the receiving chambers from the discharging chambers at any given position of the piston.

The various figures of the patent show measuring chambers of very different shapes and having different relations to each other, but the same general features of construction and the same general principles of operation are present in all. That is to say, in each there is a cylinder provided with points; there is a piston provided with points; this piston moves in an orbit around and across the centre of the case, constantly maintaining

an eccentric relation thereto, and in doing so forms a plurality of enlarging and contracting chambers by means of continually changing lines of bearing between the piston and the case. And, as we have seen, these several chambers, while they are enlarging, must be open to the inlet and closed to the outlet; and while they are discharging must be open to the outlet and closed to the inlet (Brevoort, Record, p. 16).

Portage.

Different systems of portage are shown in the drawings. In Figs. 1 to 5 the piston is its own valve. In Fig. 7 the piston operates a separate valve. The common characteristic, however, present in all, is that the ports are so arranged that an inlet port is open and the outlet port closed to the enlarging chambers, while an outlet port is open and the inlet port is closed to the contracting chambers. This is a feature which must of necessity characterize every displacement apparatus, whether it be an engine, a pump or a meter.

Referring to Figs. 1 to 5, the water which is measured flows in through a central polygonal hole in the bottom plate and out through a central polygonal hole in the top plate. The piston has crooked passages through it, the inlet passages terminating at one end in a cluster of holes on the lower end of the piston about its centre, and the outlet passages terminating in a cluster of holes around the spindle on the upper end of the piston. Both sets of passages at one end terminate on the sides of the piston where the measuring chambers are formed. The relation of the large holes in the head plates and the smaller holes in the piston is such that at every position of the piston some of these smaller holes are open and some of them are closed on both ends. The

holes that are open at the bottom of the piston communicate with the enlarging chambers and those which are closed communicate with the contracting chamber; while the holes that are open at the top of the piston communicate with the contracting chambers and those which are closed communicate with the enlarging chambers. This may be easily demonstrated by pushing a straw through the open holes at the top and bottom and observing into what chambers these crooked holes terminate at the sides of the piston. See Exhibit Skeleton Nash Meter.

It is obvious without argument that every charge in the shape, the position and the relation of the measuring chambers, due either to changes in the shape of the piston or of its case, or both, require corresponding modifications in the portage; but this is a matter of common knowledge and such changes require only ordinary mechanical skill—the principle in every case remaining the same. This being true, Nash very properly in the drawings, having shown two practical systems of portage embodying his invention in connection with some of the forms described, omitted to show the portage of others.

V.

Defendants' Meter.

(*a.*) *Defendants' meter designed after the success of the "Crown" had been demonstrated.*

The infringing meter was patented by Mr. Tilden in the month of August, 1885. In that year seven thousand, four hundred and ninety-three "Crown" meters were sold (Kelley, Q. 7, Record, p. 29). Its success and its superiority over all other meters had

been demonstrated. Any person at that time with a knowledge of the art, desiring to contrive an efficient, durable and commercially successful meter would naturally have endeavored to construct it as near as could be upon the principle and plan of the "Crown" meter.

Mr. Tilden was fully acquainted with the state of the art as he himself has testified and designed defendant's meter with Nash's patent before him (Tilden, Q. 11, Record, p. 214).

(*b.*) *Examination of Exhibit Defendants' Meter (Exhibit D).*

This meter has a case provided with points, and a piston provided with points; the piston moves in an orbit around and across the centre of the case, constantly maintaining an eccentric relation thereto, and in doing so the projections and recesses of the piston co-operate with the projections and recesses of the case to form a plurality of enlarging and contracting chambers by means of continually changing lines of contact between the piston and cylinder—all as in Exhibit E (Brevoort, Record, p. 16). See Plate V.

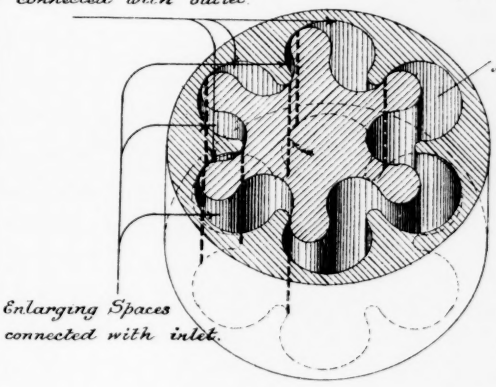
VI.

Complainants' and Defendants' Meters compared.

But between the devices show in Exhibit E and defendants' meter there is this obvious difference: in the patent the pistons revolve on their own axes while they move in an orbit around the centres of their cases. In defendants' meter the piston does not revolve on its axis while it moves in an orbit about the centre of the case.

PLATE V

Heavy dotted lines indicate the continually changing lines of bearing (separating chambers) within and upon which piston moves.



Argumentative drawing of Defendents' Meter.

Comparing these further it will be observed that in the figures of the patent the pistons have one less projection than their respective cases, while in defendants' meter the piston has the same number of projections as its case. It is this difference in the construction of the meters which causes the pistons in the one case to revolve on their axes, and which prevents the piston in the other case revolving on its axis. (See infra, p. .)

The difference between the general features of the Nash meter and defendants' meter is, therefore, only the difference between the Galloway Patented Engine and the Galloway Kinematic Engine.

As to this the experts on both sides agree.

As to the Nash meter:

Brevoort says (Record, p. 19):

"I might here refer to the book "Kinematics of Machinery," where motors are shown and delineated, having pistons with recesses and projections, the projections of the piston being one less than the projections of the cases, and which when in operation with the cases rotate on their own axes, operating precisely in the way of the Nash mechanism, minus the improvements added by Nash, and which makes his meter a practical and commercial meter."

Renwick says (Record, p. 178):

"Prior to the invention of Mr. Nash there is described in Reuleaux's Kinematics in evidence * * * on page 434, a rotary engine in several forms which has precisely the construction and mode of operation of the piston and cylinder or chamber that are described in the reissue in suit."

As to Defendant's Meter:

Brevoort, says (Record, p. 19):

"I will now turn to the Hersey meter, Complainant's Exhibit D, and compare the same with the

claims to which I have referred. Before doing so, however, I will state that the Tilden meter is, in substance, the Galloway Patented Engine with the improvements of the Nash patent added thereto, which changes makes the device commercial as a meter.

Renwick, defendant's expert, says (Record, p. 187):

"I will premise by saying that the piston and cylinder of the Hersey meter are constructed and operate precisely like the piston and cylinder of the Galloway engine disclaimed in the Nash reissue" (that is, the Galloway Patented Engine).

PART III.

DID DEFENDANTS' METER INFRINGE CLAIM 1 OF NASH ORIGINAL PATENT?

VI.—No question but that it has four out of five elements of claim.

VII.—Does its piston have an "eccentric or side-rocking" motion?

(*a.*) *Defendants' definition of term.*

(*b.*) *Complainants' definition of term.*

VIII.—Axial rotation of piston performs no function.

IX.—Meaning of words "within and upon continually changing lines."

X.—Meaning of words "across the centre of the chamber."

XI.—To what features defendants contend claim 1 is by implication limited.

(*a.*) *Revolving motion.*

(*b.*) *Relation of receiving and discharging spaces.*

(*c.*) *Contact on diametrically opposite sides.*

(*d.*) *No pressure in neutral chamber.*

Did Defendants' Meter Infringe Claim 1 of Nash Original Patent?

Each of the claims of the Nash reissue alleged to be infringed contains all the elements word-for-word of claim 1 of Nash original patent. It is, therefore, impossible for defendants' meter to infringe either of the claims of the reissue unless it infringed the first claim of the original patent.

The first question to be determined, then, is: Did defendant's meter infringe the first claim of the Nash original patent?

If it did not, we have no case.

The first claim of the Nash original patent reads (Record, p. 107):

"A piston for water meters, pumps and motors having alternate bearing points or projections and recesses, adapted by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an excentric or side-rocking motion (,) within and upon continually changing lines (,) across the centre of said chamber, to effect its division at two or more points on its sides into receiving and discharging spaces, *c*, *c*, which communicate with the inlet and outlet."

This claim is not properly punctuated. The words "within and upon continually changing lines" should be included between comas, as the words "across the centre of said chamber" which immediately follow do not refer to the "continually changing lines," but do refer to the "eccentric or side-rocking motion" of the piston. Paraphrasing this part of the claim it would read, "having an eccentric or side rocking motion across the centre of said chamber, within and upon continually changing

lines, to effect its division," &c. (see this Brief, pp. 75 and 77).

VI.

No question but that defendant's meter contains four out of five elements of original claim.

For the purpose of determining what elements of the claim are common to all displacement structures and what elements are characteristic of the meter claimed, we will compare the claim with the common piston and cylinder of Plate I.

Compare Plate I with Plate IV.

Elements of the Claim.	*Elements shown in Plate I., and distinguished from elements in original Claim 1.*
(1.) A piston having alternate bearing points or projections and recesses.	(1.) A piston; but the piston does not have alternate bearing points, or projections and recesses.
(2.) A cylinder chamber having alternate bearing points or projections and recesses.	(2.) A cylinder chamber; but the chamber does not have alternate bearing points, or projections and recesses.
(3.) The piston is to have an eccentric or side-rocking motion across the centre of the cylinder chamber.	(3.) The piston moves; but it does not have an eccentric or side-rocking motion—whatever that may be.
(4.) The cylinder chamber is to be divided at two or more points on its sides into receiving or discharging spaces, which communicate with the inlet and outlet.	(4.) The cylinder is divided on its sides into receiving and discharging spaces which communicate with the inlet and outlet; but it is not so divided at two or more points or lines.
(5.) These receiving and discharging spaces are to be separated by continually changing lines (more that one line) within and upon which the piston moves.	(5.) The receiving and discharging spaces are separated by a continually changing line within and upon which the piston moves; but it is not so separated by continually changing lines (more than one line).

Defendants' Meter Contains the First and Second Elements of the Claim.

There is no doubt but that defendants' meter has in it the *first* and *second* elements of the claim; that is, the piston has alternate bearing points, or projections and recesses; and the cylinder has alternate bearing points, or projections and recesses.

Defendants' Meter Contains the Fourth and Fifth Elements of the Claim.

There is no doubt but that defendants' meter has also in it the *fourth* and *fifth* elements of the claim; that is, its cylinder chamber is divided at two or more points on its sides into receiving and discharging spaces which communicate with the inlet and outlet; and these spaces are divided by continually changing lines (more than one line) within and upon which the piston moves. (See Plate V. and compare this with Plate IV.)

If this point is not entirely clear, it will be only necessary to refer to Mr. Tilden's description of defendants' meter in the patent under which it is made, where he says (Record, p. 146):

"that because of the shape of the wall of the chamber and of the piston, the piston is kept in contact with the wall of the chamber at a number of what I call '*contact lines*' which form the *changing* limits of measuring and discharging passages, spaces or recesses. The number of lines of contact depends, of course, upon the number of spaces or recesses. *This separation or division of the chamber is necessary*, because a full head is maintained in the larger part of the chamber, and it is of course necessary to divide the spaces or recesses or portions thereof which are successively emptied from those which are being successively filled by fluid under pressure. *This division is accomplished by contact of the piston with the wall of the chamber.* The lobes, in connection with the portions of the wall which constitute or form the spaces or recesses, also act to separate the outlet

ports from the inlet ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by *two contact lines*—one between the outer surface of the lobe and the wall of the recess and the other between the surface of the inward projection of the wall and the surface of the piston between the lobes. *These lines of contact continually advance* until the fluid has been expelled from each space or recess."

Tilden Reissue (Record, p. 151):

"It is not necessary that the main chamber and piston be shaped as represented in Fig. 4, for I have ascertained that the piston may have any number of lobes and recesses, from three upward, and that they may be of any size and of different sizes for the same piston, *the only difference to be observed being that the piston and chamber wall must be so shaped as to provide the contact lines* in the surface of the piston or chamber wall, whereby the formation of measuring chambers is effected."

The only remaining element to be considered is the third.

The only remaining element of the claim to be considered is the *third*, which requires that the piston have an "eccentric or side-rocking motion."

VII.

Does defendants' piston have an "eccentric or side-rocking motion" within the meaning of this term as employed in the first claim of the Nash Original Patent?

This is the hinge on which the question of infringement turns.

(*a.*) *Defendants' Definition.*

Defendants' counsel contend that the piston of their meter has not an "eccentric or side-rocking motion." To understand their contention we must

ascertain precisely what they understand the words "eccentric or side-rocking," employed in the original and reissued claims, to mean.

They begin by sweeping the word "eccentric" entirely out of the case. They say that in the Nash patent "eccentric" means "side-rocking," and that "side-rocking" means "eccentric." And they argue that the word "eccentric" is, therefore, superfluous and may be disregarded entirely.

Their object in wishing to sweep "eccentric" out of the case is quite obvious when we consider that this term unquestionably describes the orbit motion which is common to complainants' meter and defendants' meter—just as the term "elliptic" describes the orbit motion which is common to both the earth and the moon.

Complainants, for precisely the same reason and with exactly as much justice, might sweep the word "side-rocking" out of the case; and then there could be no question but that defendants' meter infringes the *terms* of the claim, for it certainly has an eccentric motion, always maintaining, as it does, an eccentric relation to the case as it sweeps around within it, and having an orbit motion which could be derived from an eccentric pulley. (See wooden models illustrated in Plate XIV., opposite p. .) This is precisely the motion of the piston of Fig. 10 of complainants' patent, which is shown as controlled by an "eccentric;" and of Fig. 11, which might be controlled in the same way. (See Plate XI., opposite .)

But both terms "eccentric" and "side-rocking" are in the case and neither of them can be swept out of it. A definition which ignores either of them is *prima facie* faulty.

Having thus disposed of the term "eccentric," defendants' counsel proceed to examine the figures of the Nash patent to find somewhere in them a motion which they think *ought* to be called "side-rocking."

Their definition of side-rocking is this: It is that motion (found in the structures of Figs. 3, 9 and 12 of the Nash patent) where *one point of the piston is substantially stationary while the diametrically opposite point moves through the arc of a circle.*

As it is very important to understand precisely what this definition includes and what it excludes, we have prepared an argumentative drawing illustrating what they say side-rocking is and what they say it is not. (See Plate VI.) Figs. 1 and 2 show bodies moving on a plane surface. It will be seen that in Fig. 1 the point *a* remains substantially stationary, while the diametrically opposite point *b* describes the arc of a circle. The point *d* next would come in contact with the surface and remain stationary while the diametrically opposite point *c* would pass through the arc of a circle. And so on. The *centre* of a body having that motion (when the points successively have periods of rest) necessarily describes a series of arcs, as shown, and these conditions would not be changed by causing the body to travel on a circular surface, as shown by Fig. 3, Plate VI.

Fig. 2 shows a body which defendants say does *not* side-rock. The point *x* in contact with the surface on which it travels does not at any time remain stationary, while the diametrically opposite point *y* does not at any time describe the arc of a circle, but of course the point *y* moves faster than the point *x*. The centre of a body having this motion (where there is a continuous motion without periods of rest) describes a path parallel to the surface on which it travels, whether it revolves, or does not revolve on its own axis and these conditions would not be changed by causing the body to travel on a circular surface, as is shown by Fig. 4 (which is an illustration of the diagramatic model, Complainants Exhibit K.)

PLATE VI.

Fig. 1
Side-rocking body.

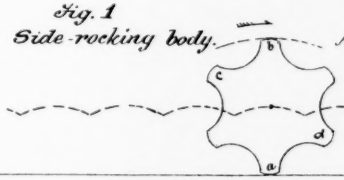


Fig. 2
Non-side-rocking body

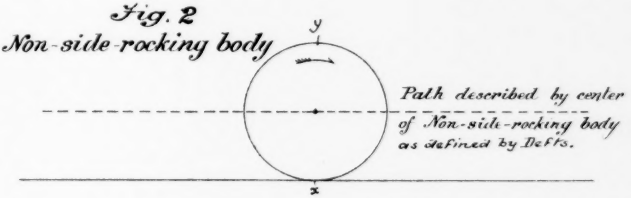


Fig. 3
Side-rock[illegible] body

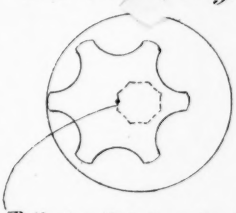
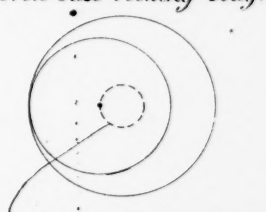
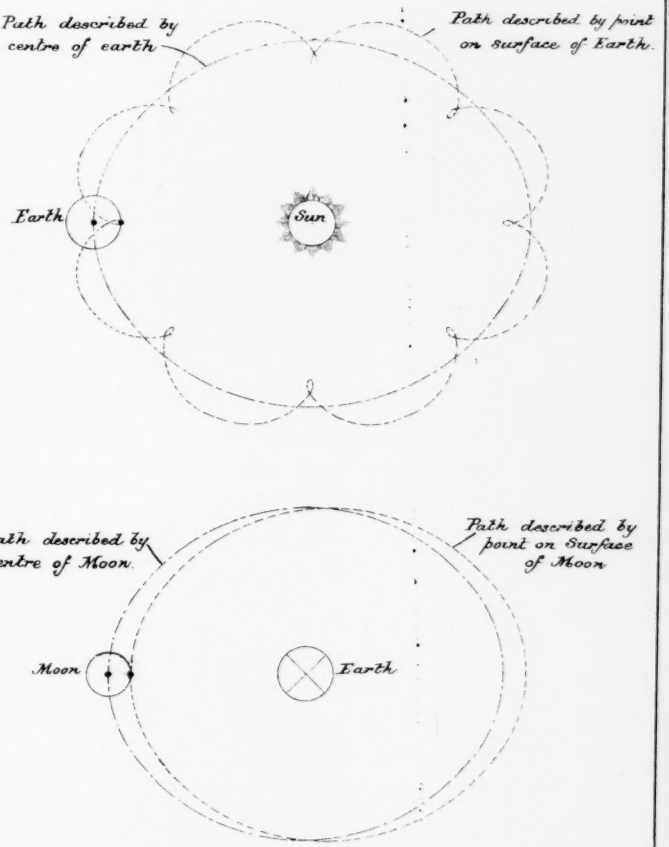


Fig. 4
Non-side-rocking body



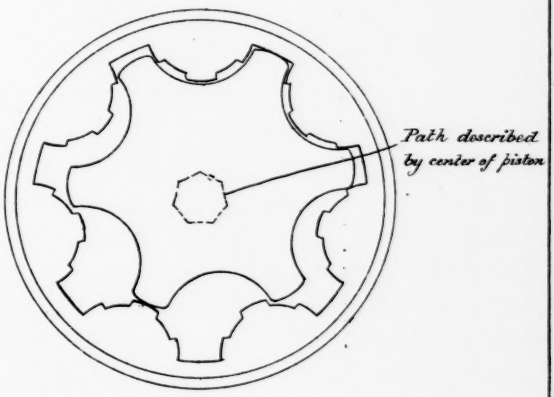
Argumentative drawing illustrating Defendents definition of a side-rocking body and a non-side-rocking body

PLATE VII.



Argumentative drawing showing that it is the path described by the center of body, having a compound motion, and not the path described by a point on its periphery, that denotes its orbit motion.

PLATE VIII



Outline of fig.3 of patent in suit showing path described by center of piston – that is, the orbit motion of piston.

We particularly direct attention to the paths described by the *centres* of these bodies because in considering a body having a compound motion (that is a motion through space and at the same time a motion about its own axis), we must look *only* at the centre of the body when we seek to determine its motion through space. For example, the earth, as we are taught, describes an elliptical orbit about the sun. But no other part of the earth except its centre describes an elliptic. The Capitol at Washington, for example, being distant from the centre, does not describe an elliptic. It describes 365 loops, or curiously shaped curves, while passing around the sun, because the earth revolves on its axis every day (see Plate VII.).

In bodies like the moon, which have no revolution, every particle describes the same path as the centre. But this is not true of bodies which have a compound motion. The *orbit* motion of such a body is the motion of the *centre* of the body with relation to some external point, while the motion *of revolution on its own axis* is the motion of the particles outside of the centre with relation to the centre.

Coming back now to defendants' definition of side-rocking motion, we see that according to it a piston the centre of which describes a *circle* about the centre of its case (that is, whose orbit motion is circular), does *not* side rock. They say it *slides.*

They say that under their definition the pistons of Figs. 3, 9 and 12 of the Nash patent do side-rock, because the centre of those pistons describe a polygon composed of concave arcs (see Plate VIII.).

They say that under their definition the piston of their meter does not side-rock because its centre describes a circle about the centre of its case (see Fig. 1 of Plate III., opposite p. 27).

Now we wish very particularly to caution against the error of supposing that all pistons having a compound motion "side-rock" under defendants'

definition. They insist that a piston may have a compound motion and yet not side-rock. This is obvious because both the wheels in Plate VI. have a compound motion like that of the earth, neither of them have a simple motion like that of the moon, and yet defendants say that one side-rocks and the other does not. As this is an important matter reference is made to what was said by defendants' counsel in their brief and argument in the Court below on the supposition that the same argument will be urged upon this appeal.

Referring to the compound motion of diagramatic model Exhibit K (see Fig. 4, Plate VI), Mr. Fish said (p. 201 of stenographer's minutes of argument below):

"*There is no side-rocking;* there is simply a sweeping around the case."

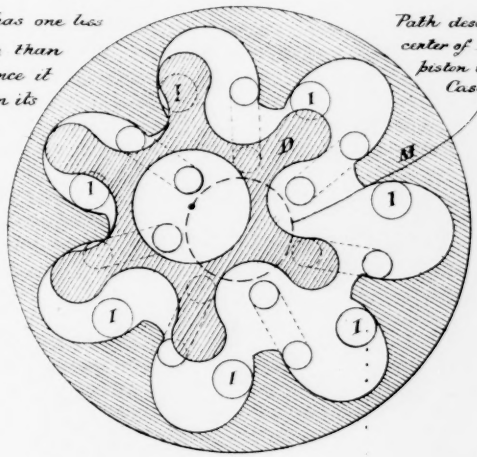
And refering to the same exhibit, at page 55 of the printed brief below, he said:

"Moreover, the difference between the motions of the complainants' and defendants' pistons is not merely that one rotates and the other does not. The Nash piston *side-rocks* as well as revolves. The defendants' piston *slides bodily* and neither side-rocks nor revolves." (Italics are theirs).

Referring to another model (case M and piston D), in which defendants' piston operates in a case where it has a compound motion (see Plate IX.), defendants' counsel, in their brief below at page 59, said:

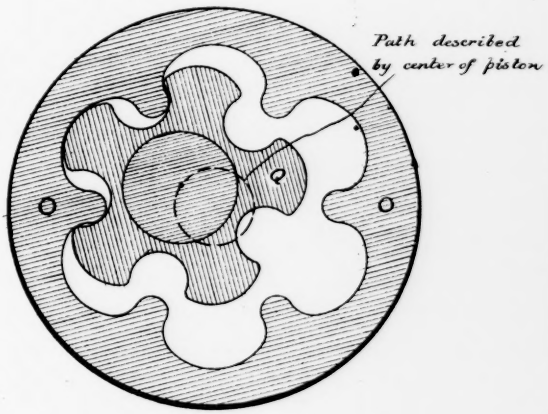
"But this combination model, case M and piston D, does not satisfy any of the requirements of the Nash patents * * * The piston *slides* and rotates; it does not *side-rock* and *rotate* as do the pistons of the Nash patent." (Italics are theirs.) * * * "If the defendants were using a meter like that made of case M and piston D, we should confidently contend that they were not infringing the Nash patent."

PLATE IX.



Drawing showing the path described by the center of Defendants' piston (orbit motion) working in Case M, where it revolves on its axis. Although having a compound motion Defendants say this piston does not "side-rock"

PLATE X



Draming showing Exhibits Piston Q in Case O where it revolves on its axis and showing path described by center of piston, i.e. orbit motion.
Although having a compound motion Defendents say this piston does not side-rock

Referring to the wooden models, piston Q in case O, where the piston has a compound motion (see Plate X.), defendants' counsel in their printed brief below, at page 63, say :

"These models again can prove nothing except the capacity of Mr. Nash and Mr. Brevoort to devise new and patentable forms of meter based upon the older forms with which they are familiar. Again, *the piston Q in case O never side-rocks.*"

According to defendants' definition, therefore, the wheel of Exhibit K when rolling around within its case does not side-rock, although it has a compound motion. Its centre describes a circle.

According to their definition piston of Exhibit D, in case M does not side-rock, although it has a compound motion. Its centre likewise describes a circle.

According to their definition piston, Exhibit Q, in case Exhibit O does not side-rock, although it has a compound motion. Its centre likewise describes a circle.

According to their definition only those compound-motion pistons do side-rock whose centres describe polygons composed of concave arcs, and the formation of such a figure is due to the fact that some point of the piston is always momentarily at rest.

If defendants were justified in sweeping the word "eccentric" out of the case, and if there were no specification annexed to this patent, and if the only form of meters shown in the drawings were those of Figs. 3, 9 and 12, their definition might be the correct one.

But the words "eccentric" and "side-rocking" must be read together, as they are both found in the specification and the claims.

Aside from this, the specification and Figs. 10 and 11 of the drawings flatly contradict defendants' definition and prove that whatever these terms do

mean, they at least do *not* mean what defendants say.

This is plain enough when we look at Figs. 10 and 11 of the patent. Fig. 10 shows a piston which is driven by an eccentric. The path of its centre *must*, therefore, of necessity *describe a circle.* The pistion of Fig. 11 also describes a circle (see Plate XI.). There is no time when one point of either of these pistons stands still, and the opposite point describes the arc of a circle. They have precisely the motion of Exhibit K and of the piston Exhibit D in the case Exhibit M, and of the piston Exhibit Q in the case Exhibit O, all of which defendants say do *not* side-rock. Under their definition, therefore, the pistons of Figs. 10 and 11 do not "side-rock." But the specification says, referring to these figures (Record, p. 104):

"Figs. 9, 10 and 11 are modified forms of the cylinder bearing points or lines and the corresponding forms of *side-rocking and rotary* pistons adapted for co-operation therewith."

It does not appear to be necessary to say anything further to prove that defendants' definition of side-rocking is not the correct one.

Concerning Figs. 10 and 11, defendants' expert said that he did not think the piston of Fig. 10 would go around when connected with an eccentric as shown, and that he thought the centre of Fig. 11 would descibe a polygon with concave sides (Renwick, x-51, Record, p. 199). So in rebuttal we produced working models of both of these figures (Exhibits S and T), the very meters, in fact, from which the draughtsman made Figs. 10 and 11 of the patent drawing. The piston of the Fig. 10 meter is controlled by an eccentric and the piston does go round (Brevoort, Q. 7, Record, p. 36). The piston of Fig. 11 describes a circle, as was proved by putting a bit of graphite in the piston at its

PLATE XI.

Fig 10 Patent in suit.

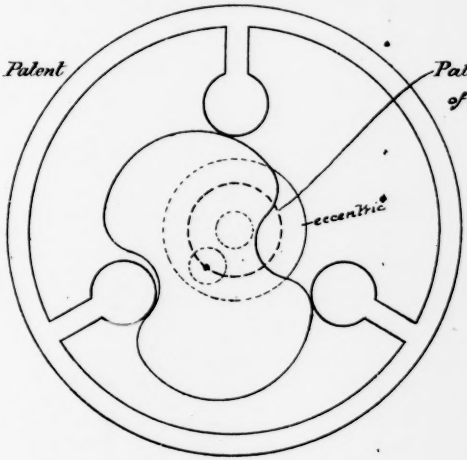
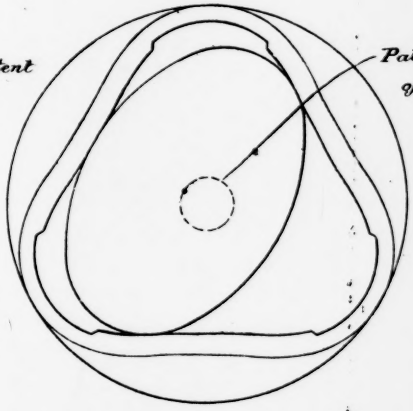


Fig. 11 Patent in suit



Outline drawings of figs 10 & 11 of the Patent in suit showing paths described by centers of pistons, i.e. orbit motions.

centre and observing the mark made by the graphite on a sheet of paper placed on the bottom of the case (Brevoort, Q. 8, Record, p. 37).

(*b.*) *Complainants' definition of "eccentric or side-rocking."*

We take our definition from the specification of the patent itself, which states in perfectly distinct and unmistakeable language what the term "eccentric or side-rocking motion" *means in this patent.*

But before we go to the specification it is important to have a clear conception of what simple motions the compound motion of the Nash pistons is made up, and what is the difference between the motions of the Nash pistons and the motion of defendants' piston.

MOTIONS OF PISTONS OF THE NASH PATENT AND OF DEFENDANTS' METER COMPARED:

The pistons of the patent in suit have two motions. They have (1) an orbit motion; that is, a motion around the centre of the case; and (2) they have besides this, a motion of revolution around their own axis.

Defendants' piston has only one motion; that is, an orbit motion—a motion around the centre of its case. It has no motion of revolution around its own axis.

The *orbit* motion of defendants' piston and that of the Nash pistons of Figs. 10 and 11 is precisely the same—the orbit motion of each is a true circle. The motion of Nash pistons Figs. 3, 9 and 12 is not a circle; it is a polygon composed of concave arcs. This difference, however, is entirely immaterial, and is admitted to be so by defendants. In the patent to

Tilden under which defendants' meter is made, it is stated (Record, p. 152):

"While the invention, as shown in the drawings, represents a piston which, while not rotating, moves in a circular path, yet, by changing the form of of the piston lobes and the shape of the walls of the chamber, the piston may be made to take a *square, rectangular, elliptical or any other shape,* the condition governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber and the relation which may bear to each other; *but while these different movements may be given to the piston, the principle of the action is not changed.*"

Figs. 16, 17 and 18 of said Tilden patent drawings are reproduced on Plate XII. Describing these, the patent says (Record, p. 148):

"Figs. 16, 17 and 18 are diagrams showing that changes in the form and size of the chambers, spaces and pistons *do not vary the principle of the construction.*"

The several orbit motions of the Nash pistons are, therefore, *substantially* the same.

A familiar illustration will, perhaps, make the distinction between the motions of complainants' and defendants' piston clearer. The earth has an orbit motion around the sun. It also has a motion of rotation on its own axis. It has, therefore, a compound motion. The moon has a similar orbit motion around the earth, but it has no motion of rotation on its own axis.

Complainants' piston has the compound motion of the earth. Defendants' piston has the simple motion of the moon.

This illustration would be perfectly accurate were it not for the fact that (as the moon always keeps the same side towards the earth) it really revolves slowly on its axis. However, this motion of revolution is so slow that the moon is popularly believed

PLATE XII

8 Sheets—Sheet 7.

J. A. TILDEN.

Assignor, by mesne assignments, to the HERSEY METER COMPANY.

WATER METER WITH REVOLVING PISTONS.

No. 10,778. Reissued Nov. 2, 1886.

Fig. 16.

Fig. 17.

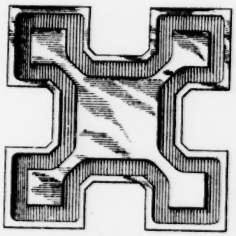


Fig. 18.

WITNESSES.

Fred. B. Dolan

INVENTOR.

James A. Tilden

Figs. 16, 17, and 18 are diagrams showing that changes in the form and size of the chambers, spaces, and pistons do not vary the principle of the construction.

While the invention as shown in the drawings represents a piston which, while not rotating, moves in a circular path, yet by changing the forms of the piston lobes and the shape of the walls of the chamber the piston may be made to take a square, rectangular, elliptical, or any other shape, the conditions governing these various movements depending entirely upon the shape of the surface of the piston, the surface of the wall of the chamber, and the relation which they bear to each other; but while these different movements may be given to the piston, the principle of its action is not changed,

not to revolve at all, and for the purposes of this discussion we will suppose that this is really the fact.

This illustration pressed further will serve to make clear still another point. The earth does not fall into the sun because of its orbit motion. Its motion of revolution is purely incidental as far as this is concerned. It has nothing whatever to do with keeping it out of the sun.

The moon has the same orbit motion as the earth and does not fall upon the earth because of this orbit motion.

A patent claim on the earth having in view its ability to retain its position in the solar system would not be, if properly drawn, limited to this motion of revolution around its own axis (because it is purely incidental) and such a claim would be infringed by the moon, although the moon does not revolve on its axis as the earth does.

We contend that in precisely the same sense the revolution of the Nash piston around its own axis has nothing whatever to do with any of its functions in a water meter, and that, being properly drawn, the claim was not limited to such motion and is infringed by defendants' meter in which the piston does not revolve on its own axis.

There is no difficulty in dissecting the compound motion of a piston in any given case. In every case its orbit motion is the motion of its centre, as we have seen. The only other motion it has or can have is a motion of revolution about its axis.

The patent defines "*eccentric or side-rocking*" motion as the *orbit motion* of the piston.

Now, bearing in mind that the Nash pistons have the compound motion of the earth and that they have *only two motions*: (1) an orbit motion; and (2) a motion of revolution on their axis, we will examine the specification to ascertain, if we can, directly from it what the term "eccentric or side-rocking motion" means in the claim.

The patent reads (Record, p. 102):

"In my improved meter I use a piston adapted to have an *eccentric or side-rocking* motion across the centre of a cylinder chamber to effect its division at two or more points into receiving and discharging spaces. The piston operates with two or more continually changing points or lines of bearing or contact with two or more points or contact bearings of the cylinder at different points at the same time, by which the receiving and discharging spaces of the cylinder are caused to continually change their volume with an unobstructed flow and a positive displacement of the water from the discharging space of the cylinder by the rocking of the piston from one bearing point to another across the chamber of the cylinder. *With this eccentric or side-rocking motion the piston also revolves around its own centre, and both these movements* are effected by the relative shape of the piston and cylinder, and by the direct action of the water upon the piston; for, as the piston *rocks from one bearing point to another* directly across the centre of the cylinder, *it is at the same time revolved* to effect the measurement of the water passing into and from the cylinder spaces."

Now the Nash pistons all have two motions, and none of them have more than two motions. Indeed, it is impossible to conceive of a body having *more* than two *continuous* motions. The specification says, as plainly as language can say it: My pistons have two motions, one is "eccentric or side-rocking," and the other is a "revolution around its own centre." There can be no difference of opinion as to which of the two motions the term "revolution around its own centre" described. As the only other motion the piston has is its *orbit* motion, the term "eccentric or side-rocking" must describe that.

There is nothing indefinite about this. If a man is told which his right hand is, he has just as definitely been told which is his left.

Defendants' definition of "side-rocking" (they have swept "eccentric" out of the case) obliterates

all distinction between orbit motion and motion of revolution around its axis. They contend that both the orbit motion and the motion of revolution are included in the term "side-rocking." In their supplemental brief below, page 4, they said:

"By as much as the piston side-rocks, by so much does it rotate. It cannot move without rotating upon its own axis. *Indeed, its motion of rotation and its motion of side-rocking are one and the same.*"

That must be true under their definition, but here we see they flatly contradict the specification, which does not employ the term "side-rocking" to include the revolution of the piston on its axis. It employs, as we shall see, the term "compound" when referring to the total motion of the piston.

The specification continues, bottom of page 102:

"And to accommodate this eccentric or side-rocking motion of the piston it must have a free and shifting connection with the crank or mover of the registering mechanism."

And again in the clause immediately preceding the claims (page 107):

"It will be seen that the connection of the piston with the registering mechanism is such as to allow of a free and shifting action to accommodate the side rocking movements of the piston across the centre of the cylinder chamber."

Now we have seen that the eccentric or side-rocking movement of the piston is its orbit motion. The inventor therefore says here that to accommodate the *orbit motion* of the pistons shown he has attached them to the registering mechanism by a free and shifting connection and not by a crank. As the orbit motion of some of the pistons shown (see Plate VIII.) is not a circle but a polygon made

up of concave arcs, we find in this statement further confirmation of the fact already ascertained, that the eccentric or side rocking motion of the piston is its orbit motion.

The specification continues thus (Record, p. 103):

"The continually changing points or lines of bearing of the piston and cylinder are formed by alternate projections and recesses, and *the eccentric or side-rocking movement of the piston is governed by the extent of the projecting bearing points and the depth of the recesses.*"

If the term "eccentric or side-rocking" refers to the orbit motion of the piston this statement is perfectly accurate. If, as defendants contend, the term refers to the *total* motion of the piston and is synonymous with rotation on its own axis, the statement is absolute nonsense.

As we read it, the specification here states that the *orbit motion* of the piston is governed by the *extent* of the projecting bearing points and the *depth* of the recesses, and this is true (see Plate XIII.). The longer the projections on the piston and the deeper the recesses in the case the larger will be the orbit described by the piston, other things being equal, just as the patent says

Having told us what governs the *orbit* motion of the piston the patentee proceeds to tell us what is effected by the *motion of rotation* around its axis. Continuing it says:

"So that in the rotation of the piston around its own centre one or more projecting bearing points will pass into corresponding recesses at one point of the cylinder and in contact with and over one or more projecting bearing points of the cylinder at a different point," &c.

It says that it is this motion of rotation on its axis that causes a point of the piston to pass in contact with and over a point in the case (or, in other words,

PLATE XIII

As this piston has long projections & the case has deep recesses its orbit is comparatively large

Fig. 1

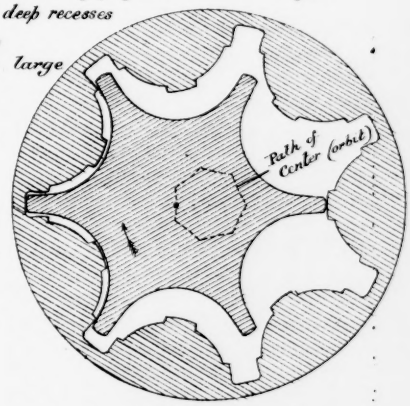
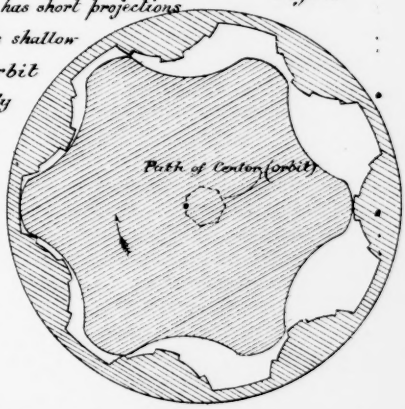


Fig. 2

As this piston has short projections & the case has shallow recesses its orbit is comparatively small



Argumentative drawing showing that it is the length of the projections and the depth of the recesses that determine the size of the orbit described by the center of the piston, as stated in the Nash Patent

causes a projection on the piston to visit in succession all the recesses in the case), which again is perfectly true.

So we see here, too, the patentee treats the two motions separately, and separately states the functions due to each, instead of mixing them up as defendants do, who insist that "*its motion of rotation and its motion of side-rocking are one and the same*" (Supplemental Brief below, p. 4).

Then a little further down on the same page, in the fourth paragraph, describing the operation of the valve, the patentee speaks of the "*eccentric or side-rocking* AND *rotary* movements of the piston." If the motion of rotation and its motion of side-rocking are one and the same, as defendants say, the patentee here might as well have spoken of the "side-rocking and side-rocking movements of the pistons" or the "rotary and rotary movements of the piston."

So also in the brief description of the figure of drawing (Record, p. 104), it says:

> "Fig. 3 * * * showing * * * the *rotary and side-rocking* piston. * * Fig. 4, the *rotary and side-rocking piston.* * * Fig. 7, the *rotary and side-rocking* piston * * * Figs. 9, 10 and 11, * * forms of *side-rocking and rotary* pistons."

Then, in the last paragraph on the same page (104) describing the drawings, it says:

> The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses *a a'* and projections *b b'*, of such form or configuration as to allow of the *rotation of the piston not only upon its own axis, but around and across the centre of the cylinder*, and the space within the cylinder must be of such form and sufficiently larger than the piston H to allow it to have this *compound motion.*"

This is the first time in the specification that the term "compound motion" appears. The patentee here says, as plainly as language can say it, that the pistons shown in the drawings have a *compound* motion, which is made up of two simple motions, to wit, "*the rotation of the piston, not only upon its own axis, but around and across the centre of the cylinder*" --just as we would say that the earth has a compound motion consisting of its *rotation not only upon its own axis, but around the sun.* We should not say "around and *across*" the sun, because the earth never overlaps the sun, as the pistons of the Nash meters and the piston of defendants' meter always do overlap the centre of the cases in which they operate.

To recapitulate:

At the beginning of the specification the inventor says:

The piston I have shown in the drawin s has *two* motions, consisting of (1) "*an eccentric or side-rocking motion across the centre of the cylinder,*" and (2) a motion of rotation on its own axis.

At this point in the specification the inventor says:

The piston I have shown in the drawings has a *compound* motion, consisting of (1) a "*motion of rotation around and across the centre of the cylinder,*" and (2) a motion of rotation on its own axis.

As things which are equal to the same thing must be equal to each other, these two passages read together define in unmistakable terms the "eccentric or side-rocking motion across the centre of the cylinder" to be the "rotation of the piston around and across the centre of the cylinder." There is no mistaking what that is--it is its *orbit* motion as distinguished from its motion of rotation on its axis.

This is precisely the term which Tilden employs to describe the orbit motion of defendants' piston (see Record, bottom of p. 145):

"The meter can hardly be called a 'rotary' meter, because it does not rotate on its own axis, although *it does revolve about the centre of the case.*"

PLATE XIV.

Fig. 1

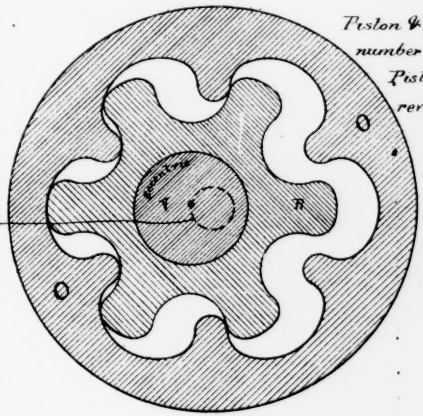
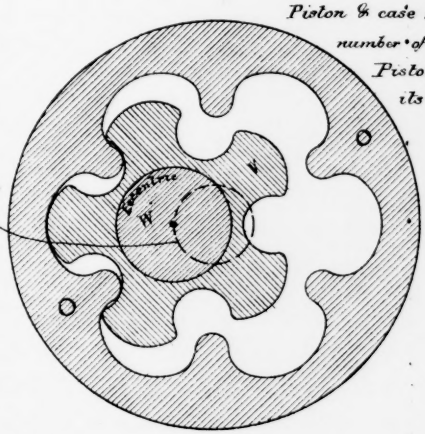


Fig. 2



Drawing of Exhibits O, R, T & W showing (1) that rotation or non-rotation of piston is due to relative number of projection on piston & case; and (2) that both may be driven by an eccentric, and both have an "eccentric motion"

Then, continuing, in the first complete paragraph of page 105, the Nast patent tells us to what the compound motion of these pistons is due. It says:

"The *compound motion* of the pistons and the contacting dividing points are due to the fact that the piston has one or more less points or projections than the cylinder."

Defendants' expert several times in his deposition misquoted this passage, making it read that the *side rocking* motion of the piston was due to having one or more less points than the cylinder (Q. 12, Record, p. 186; Q. 14, pp. 187 and 189); but that is not what it says. If it did we would have no case —for the claim is limited to a piston having an eccentric or side-rocking motion, and defendants' piston and case have an equal number of points.

But what the patent says is that the *compound* motion of the piston is due to that feature, and so it is, as is shown by first putting in the wooden case having six points, Exhibit O, a piston having six points, Exhibit R, and observing that this piston has a simple orbit motion; and then removing this piston and replacing it in the same case with a piston exactly like the other, except that it has only five points (Exhibit V.), and observing that this has a *compound* motion (see Plate XIV.).

The same fact is demonstrated again by taking defendants' piston out of its case, which has an equal number of points, and in which it has no compound motion, and placing it in case Exhibit M, which is exactly similar except that it has one more point, and observing that it here has a compound motion. (See Plate IX., opposite p. .)

Further down on the same page (105), next to last paragraph, the patentee speaks of the motion of the piston as a "compound *rotation and cross-movement.*"

Claim 2 says the piston is to "revolve while it *also*

rocks * * * across the centre of the cylinder chamber (Record, p. 107).

Claim 3 says the piston has "an eccentric or side-rocking movement across the centre of the cylinder chamber, *and* a revolving motion" (Record, p. 107).

Claim 4 says it has "an eccentric or side rocking motion across the centre of the cylinder chamber, *and* a revolving motion around its own centre" (Record, p. 107).

Claim 6 speaks of the "side-rocking *and* rotary movements" (Record, p. 108).

Claim 8 says it has a "side-rocking motion across the centre of the cylinder *and* a rotary motion around its own centre" (Record, p. 108).

We have now called attention to every place where the word "side-rocking" is found in the specification, and we submit that the patent defines the term "eccentric or side-rocking motion across the centre of the cylinder" to be the *orbit* motion of the piston, and that it nowhere employs it as a synonym for "compound motion," and that it nowhere uses it to include the rotation of the piston on its own axis.

Distinguishing the terms employed in the patent, Brevoort says (Record, pp. 39 and 40):

"I understand that the compound motion referred to in the patent is the motion that the piston has when it is both sweeping around the case aud rotating on its own centre,"

* * * * * * *

"I will now illustrate what I now understand the patent means by the eccentric or side recking motion. And to do this I will again refer to Exhibit K, but I will hold the piston and prevent its rotation on its axis. Now, as I move the piston around in the case it will be seen that its motion is that of an eccentric, and this can also be illustrated by taking the case P and putting in the eccentric V and piston *V*, when it will be seen that a simple eccentric motion is had and not a compound motion. To illustrate the compound motion again, I will put the

piston V in the case O and place the eccentric W in position when it will be seen that the piston has a compound motion, that is, an eccentric motion and a motion of rotation on its own axis."

Evidence that Nash did not intend the first claim of his original patent to be limited to pistons which rotate on their axes.

But the terms of the claims themselves afford additional proof of the fact that "eccentric or side-rocking" does not include the rotation of the piston on its axis, as defendants contend it does.

The second claim is in substance for indentically the subject matter of the first, except that it is limited to a piston which revolves on its axis. Claims 3, 4, 6 and 8 are similarly limited (Record, p. 107).

Original Claim 2; *Reissue Claim* 7. The piston of a water meter, pump or motor constructed with alternate recesses and bearing points or projections *a* and *b* and a cylinder chamber having alternate wall recesses and bearing points or projections *a'* and *b'*, adapted to intermatch with each other at one or more bearing points at one side of the cylinder and allow the projections of each part to bear upon and *to pass* each other at two or more points at a different side of the chamber to allow the piston to *revolve while it also rocks* in constantly changing lines across the centre of the cylinder chamber, for the purpose stated.

Original Claim 3; *Reissue Claim* 8. The piston of a water meter adapted to have an *eccentric or side-rocking movement across the centre of the cylinder chamber and a revolving motion*, combined with a registering mechanism by means of a free or shifting connection acting with the continually changing side-rocking movements of the piston while maintaining a driving relation with the dial mechanism.

Original Claim 4; *Reissue Claim* 9. The combination with a piston having an *eccentric or side-rocking motion across the centre of the cylinder chamber and a revolving motion around its own*

centre to divide the cylinder at two or more bearing points on its sides, of a valve controlled by the movements of said piston and adapted to open and to close receiving and discharging ports in succession, to effect the purpose stated.

Original Claim 8; *Reissue Claim* 13. The spaces or recesses *c'* in the walls of the cylinder, between the bearing *b'* and the recesses *a'* in combination with the piston having alternate bearing points and recesses, whereby to prevent the choking of the flow and insure a uniform action of a piston adapted for operation with a *side-rocking motion across the centre of the cylinder, and a rotary motion around its own centre.*

Further evidence that Nash did not use the term "eccentric or side-rocking," to include the rotation of the pistons about their axes, is found in his patent of January 28, 1879.

In the patent to Nash issued January 28, 1879, one week later than the original of the patent in suit, the application for which was pending in the Patent Office contemporaneously, and the specification of which was probably in print when said original patent was issued, the inventor, referring to this patent, says (Record, p. 108):

"In a patent bearing date January 21, 1879, No. 211,582, I have described and shown a piston of a water meter, adapted to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of the cylinder chamber, to effect the division of said chamber at two or more continually changing points on its sides into receiving and discharging spaces which communicate with the inlet and outlet, *the piston having also a revolving motion around its own centre.*

Here we have a word-for-word copy of the first claim of the patent in suit, at the end of which the inventor adds, "*the said piston having also a revolving motion around its own centre.*"

As a contemporaneous instrument, reference may properly be made to this patent to ascertain what signification the inventor himself, at the time, attached to the words "eccentric or side-rocking" motion, and to show what subject matter he intended to cover by the first claim of the original patent. It shows very clearly that in his opinion the language of the first claim of his patent, issued a week earlier, made no reference to the revolution of the piston on its own centre, and was not limited to structures having that feature.

AS "ECCENTRIC OR SIDE-ROCKING" IS THE ORBIT MOTION OF THE PISTON, DEFENDANTS INFRINGE THE FIRST CLAIM OF NASH'S ORIGINAL PATENT.

We have seen (*supra*, p.) that the claim contains five elements. That defendants' meter has in it the first, second, fourth and fifth elements of the claim admits of no possible doubt, and concerning this, as far as we know, there is no difference of opinion. The third element is a piston having an eccentric or side-rocking motion. This, we have seen, is the orbit motion of the piston. Defendants certainly infringe, for the orbit motion of their piston, being circular, is precisely the orbit motion of the Nash pistons of Figs. 10 and 11 of the patent drawings.)

VIII.

THE ROTATION OF THE PISTON ON ITS AXIS HAS NOTHING TO DO WITH ITS FUNCTIONS. IT IS, THEREFORE, A PURELY INCIDENTAL FEATURE TO WHICH THE FIRST CLAIM OF THE NASH ORIGINAL PATENT, IF PROPERLY DRAWN, WOULD NOT HAVE BEEN LIMITED.

The *first* function of the piston is to divide the space within the cyclinder into two or more chambers which by its motion are caused to enlarge and

contract. Its *second* function is to work the registering mechanism so that the number of times the chambers have filled and emptied shall be recorded. (See Plate I.) In the simplest type of displacement meter the piston has no other function; but in the meter of the Nash patent it has a *third* function, to wit: it acts as its own valve, controlling the ports which admit and discharge the water. These are all the functions of the piston.

The question arises, which motion of the piston—the orbit motion, or the motion of rotation on its axis—performs each of these three functions?

First Function of Piston.

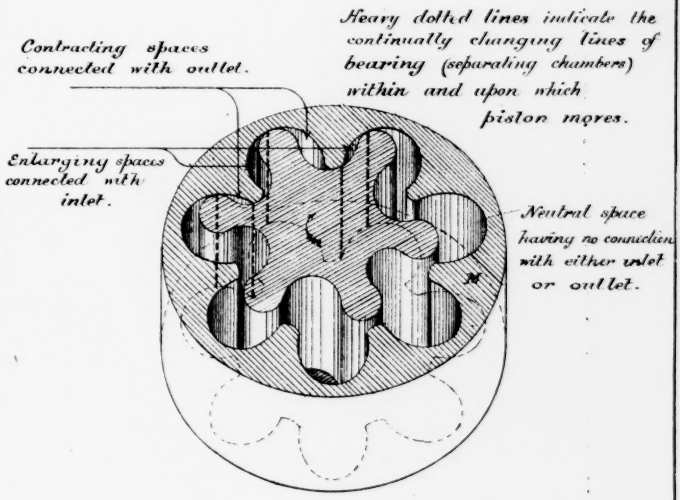
We will first inquire as to the displacing action of the piston, that is, its capacity for forming enlarging and contracting measuring chambers within the cylinder.

Plate V. (which is repeated here for comparison) shows defendants' meter and just how the enlarging and contracting chambers are formed and how they are located with relation to each other. We see that some of the depressions in the cylinder are divided by a lobe of the piston into enlarging spaces on one side and contracting spaces on the opposite side. All the contracting spaces are on one side of the piston and all the enlarging spaces on the opposite side.

Plate XV. shows this same piston placed in the case Exhibit M, which has on it one more projection and in which the piston, therefore, revolves on its axis. A comparison of this Plate V. with Plate XV. will show that the enlarging and contracting chambers in both are formed in precisely the same way and with precisely the same relation to each other.

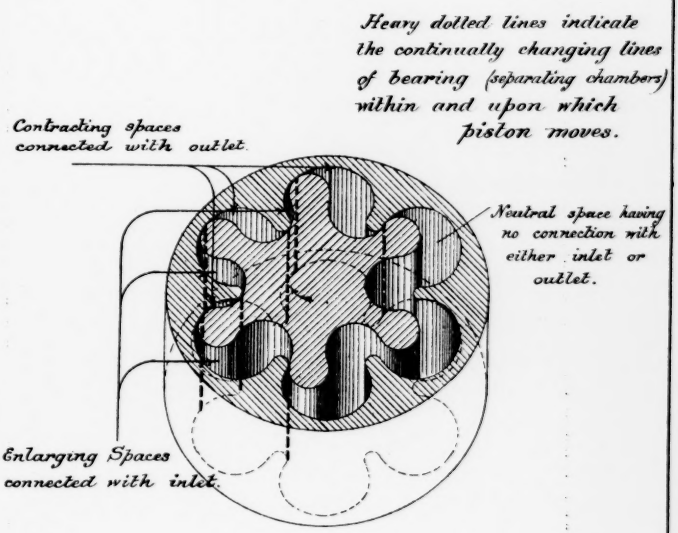
Now, as the measuring chambers are formed in precisely the same way by this same piston, whether

PLATE XV



Argumentative drawing of piston of Defendents' Meter put in Case M (having one more projection) & in which the piston has the compound motion of the Nash Pistons

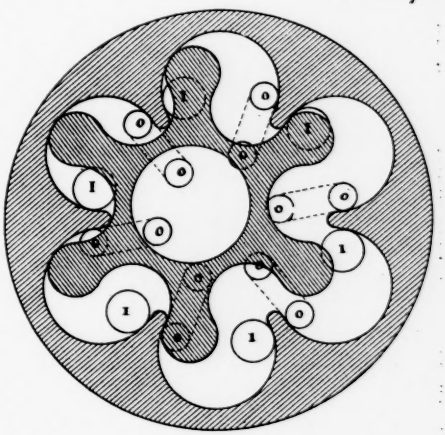
PLATE V



Argumentative drawing of Defendents' Meter.

PLATE XVI

I are inlet ports.
O, O. are connecting outlet ports.

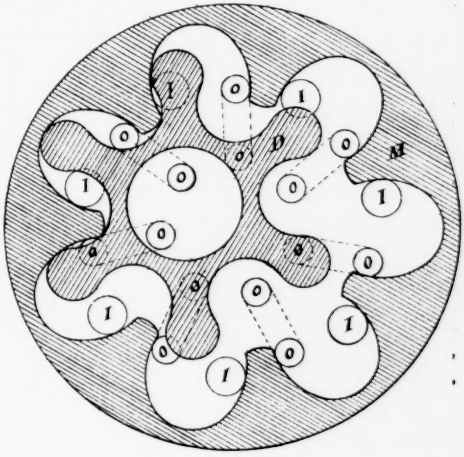


Drawing showing portage of Defendents' Meter and how the piston controls the ports.

PLATE XVII

I, are inlet ports

O, O, are connecting outlet ports



Drawing of Defendents' piston in Case M, where it has a compound motion, showing portage & how the piston controls the ports.

it revolves or does not revolve on its axis, this is submitted as a *demonstration* of the fact that the rotation of the piston on its axis is incidental purely so far as the formation of measuring chambers within its case is concerned. It is clearly the orbit motion alone that does this.

Second Function of Piston.

The next question is, does the orbit motion of the piston or does its rotation on its axis work the registering mechanism?

In both meters the main driving-wheel of the registering mechanism is connected to a pin which has on it a laterally projecting arm against which a spindle projecting from the piston at its axis impinges. It is the motion of translation of this pin—that is, its orbit motion—that drives the registering mechanism. The fact that the registering mechanism in defendants' meter where the piston does not rotate on its axis, is driven in precisely the same way and by precisely the same means as the registering mechanism in the Nash meter, where the piston does rotate on its axis, answers this question and proves conclusively that it is the orbit motion of the piston that drives the registering mechanism and *demonstrates* that the rotation of the piston is incidental purely as far as its function of working the registering mechanism is concerned. It is clearly the orbit motion alone that does this.

Third Function of Piston.

The next question is, does the orbit motion of the piston, or the motion of rotation on its axis control the ports, this being a function of both complainants' and defendants' pistons?

Plate XVI. shows defendants' piston in its own case, and Plate XVII. shows the same piston in the case, Exhibit M, the portage of both cases being the

same. It will be seen that in both figures to each of the enlarging spaces inlet ports are open, and to each of the contracting spaces outlet ports are open, and that as the outlet ports are closed to the chambers which are neither enlarging or contracting (and are therefore neutral) no water flows into or out of them. This is true in every position of the piston in both figures. If it were not true neither of these meters would be operative. The fact that defendants' piston in case Exhibit M makes an operative meter is fully proved in this case (see Brevoort, Q. 5, Record, pp. 35 and 36). Now, as the same ports are controlled in the same way whether the piston does or does not rotate on its axis, this is submitted as a *demonstration* of the fact that the rotation of the piston on its axis is incidental purely, so far as the piston's function of controlling its ports is concerned. It is clearly the orbit motion alone that does this.

This case M with defendants' piston in it is submitted as a complete demonstration of the fact, when considered in connection with defendants' meter, that the revolution of the piston on its axis has nothing to do with the formation of the measuring chambers, or the control of the ports leading to said chambers, or driving the registering mechanism. These are all the functions which the pistons in these meters have.

The wooden models with interchangeable pistons, Exhibits O, P, Q and R, demonstrate the same fact.

Brevoort, in answer to question 5, Record p. 35, says:

"I have caused to be constructed a meter case and two sets of heads. The other case which I shall use for the purpose of illustration is the defendants' meter and its piston. I now take case marked M, with its heads and the piston from defendant's meter; I put in it a piston with the Nash portage as shown in the patent, and I put upon this meter the two head plates as shown in the Nash patent.

"It will be seen by operating the piston of this meter model N by hand, that the piston does not rotate on its own centre, but moves in the case as does the piston of defendants' meter, and it will be seen that this movement is accomplished by openings or ports which are the same substantially as those shown in the Nash patent. The other meter, the case of which is marked M, now has in it the piston taken from the defendants' meter, and by operating it by hand it will be seen that the piston moves about in the case, and in doing so it rotates on its own axis, and by examining the head-plates it will be seen that the meter has substantially the portage of the defendants' meters, I have tried these two meters and I know that they will operate.

"These illustrative exhibits I think clearly show and demonstrate the fact that the rotation of the piston on its own axis is not a point of difference that is either substantial or material, for they show that one form with one kind of portage and the other form with the other kind of portage can be successfully used."

As the rotation of the piston on its axis is, therefore, a detail of construction which has nothing to do with the working of the device or with either of the functions performed by the piston, the claims of the patent, or some of them, if properly drawn, would not have been limited to this purely incidental feature, just as a claim on the earth, having in view its ability to keep out of the sun, would not, if properly drawn, be limited to the revolution of the earth on its axis, and would be infringed by the moon, which does not revolve on its axis while passing around the earth.

Defendants' Criticism of Case M.

All that defendants' counsel can say against this demonstration is that in case M, with their piston in it we used a shorter spindle in the piston, one that did not extend up through the head-plate. The simple facts about this matter are these: This piston

taken out of defendants' meter has such *long points* on it that when placed in case M, which is large enough to permit axial rotation, its centre describes so large an orbit that if the spindle projected through the head-plate there would have to be a hole in the head-plate so large as to cut away some of the ports in the head-plate. To avoid this, we discharged the water through the bottom head-plate instead of the top head-plate—that is all. The operation of no part is altered in the least by such change. If there had been my reason to use a piston spindle projecting up through the case, it would have been easy enough to do it, for Nash in his patent tells us how it may be done. To diminish the size of the circle described by the centre of the piston it is only necessary to *shorten* the piston's lobes (see Plate XIII.). We preferred, however, for obvious reasons, to take defendants' piston just as it was and to put it in the case just like their case, except that it has one more projection or recess, as a more convincing demonstration of the fact that the rotation of the piston on its axis did not effect its operation as a piston in any particular, either in forming measuring chambers, or in controlling ports, or in working the registering mechanism. Even in this form the water could have been discharged through the top plate if there had been any reason for doing so.

Brevoort (Record, p. 74), says:

242 RD-Q. Referring to the exhibit composed of the piston D, and the cylinder and heads marked M, your attention has been called to the fact that in this exhibit there is a central hole in the bottom plate and there is no central hole in the top plate, while in defendants' meter there is a central hole in the top plate and no central hole in the bottom plate. Might the central hole in that exhibit as well have been made in the top plate, and the bottom plate made without a hole, so that the relation

thereof would have been the same as in defendants' meter?

A. Yes; by cutting the central spindle of the piston shorter, so that its top is even with the top of the piston, and then carrying the shaft of the counter mechanism in a spindle within a hole of the proper size and then using the same crank now on Exhibit M.

243 RD-Q. Is or is not, in your opinion, the function of the parts in any way changed by having a central hole in the bottom plate instead of the top, and is there any other reason for arranging it as shown in the exhibit except the convenience of attaching the registering mechanism and driving it thereby?

A. The function of the parts is in no way altered, and the arrangement was adopted merely for convenience of attaching the registering device.

A word in defense of Nash's use of the term "eccentric or side-rocking" to describe the orbit motion common to all these pistons.

We do not think it makes any material difference whether the terms employed by the patentee were happily chosen or not. If he had chosen to call the orbit motion "x-y-z," we think the claim would have been perfectly good, provided it could be determined from the specification what motion was described by that term. However, whether the terms which he does employ were happily chosen or not, one thing is certain—nobody connected with this case has as yet suggested better ones. Defendants' counsel say that their piston has not an eccentric or side-rocking motion, but has a *sliding* motion—a term which can hardly be said to be better.

It is easy to see why Nash employed the term "eccentric or side-rocking" to denote the orbit motion of the piston.

The piston always stands eccentric with relation to its case (is never concentric), and moves around always maintaining its eccentric relation thereto.

This is equally true of the Nash pistons, which rotate on their axes, and of defendants' piston, which does not rotate on its axis. It is an essential characteristic of such structures. The word "eccentric" accurately describes the orbit motion common to all forms.

Tilden uses the same term in his patent under which defendants' meter is made, reissued November 2, 1886, and here in evidence, where he says, describing the motions of his piston (Reissue, Record, p. 145):

"If the piston is placed centrally within the chamber, its irregular peripheral surface will be concentric to the opposed interior surface of the chamber, and the distance between said surfaces will be the radius of the extent of the piston's movement, and its contacts result, not from mechanical means, but from hydraulic action of the fluid in passing through the meter, during which time *the piston is eccentric within the chamber.*"

Brevoort, Record, p. 39, referring to the wooden models, piston V in case O, says:

"These two exhibits clearly show that the motion of the piston, either in the defendants' or in the Nash meter, are both eccentric motions; that the pistons move, when driven by an eccentric, with the same motion they would have if they ran against the interior of the case; the pistons in the illustrations which I gave being merely straps surrounding an eccentric pulley and moved in eccentric motions thereby. The eccentric pulley Exhibits V and W are such as might be found on almost any steam engine; and they operate in the same way and have the same motion as ordinary eccentrics have."

The word "side-rocking" describes the same thing viewed from another standpoint. As the patent says, the piston side-rocks "from one bearing point to another." Considering the total revolution of the piston around the centre of the case

(orbit motion) as made up of a series of arcs, as indeed it is, the motion through each arc may well be called a side-rocking motion. Considering its orbit motion from one bearing point to another, the piston side rocks in precisely the same sense whether it rotates as the Nash pistons, or does not rotate as defendants' piston.

If Nash's selection of terms is not above criticism (and we think it is), yet it should be borne in mind that the art does not supply a single term which is definitely descriptive of all the orbit motions that such pistons may have. Tilden himself says in his patent (Record, p. 152; see Plate XII.) that the orbit motion of the piston may be "circular, square, rectangular, elliptical or any other shape, without changing the principle of action." Such being the case, what more descriptive term than "eccentric or side-rocking," which certainly does describe the motion common to all these forms, could have been employed?

SIGNIFICANCE OF THE WORDS "WITHIN AND UPON CONTINUALLY CHANGING LINES" EMPLOYED IN THE CLAIM.

The first claim of the original patent describes the piston as—

"Adapted to have an eccentric or side-rocking motion (,) within and upon continually changing lines (,) across the centre of said chamber (,) to effect its division at two or more points on its sides into receiving and discharging spaces, which communicate with the inlet and outlet."

The absence of punctuation renders the claim, if it be read without any knowledge of the structure to which it applies, and without any familiarity with the specification which precedes it, in a sense, ambiguous. There is no ambiguity if we are acquainted with the devices referred to, because the "continu-

ally changing lines * * * to effect the division of a chamber at two or more points on its side into receiving and discharging spaces," we instantly recognize as the vertical lines of division, which, of course, do not cross the case. The meaning of the claim is perfectly clear if it be read in connection with the opening paragraph of the specification:

SPECIFICATION.

I use *a piston*

adapted

to have an eccentric or side-rocking motion *across the centre of* a cylinder *chamber, to effect its division at two or more points into receiving and discharging spaces.*

The piston operates with two or more continually changing points or lines of bearing, or contact with two or more points or contact bearings of the cylinder at different points at the same time, by which the receiving and discharging spaces of the cylinder are caused to continually change their volume.

CLAIM.

A piston for water meters, pumps and motors having alternate bearing points or projections and recesses *adapted*, by means of a cylinder chamber having alternate bearing points or projections and recesses, *to have an eccentric or side-rocking* movement within and upon continually changing lines *across the centre of* said *chamber to effect its division at two or more points* on its sides *into receiving and discharging spaces.*

All the difficulty disappears if the claim be punctuated as indicated above.

That this is the proper reading of the claim is further shown by the fact that the specification eight times uses the words "across the centre of the cylinder" and *always* as descriptive of the motion of the piston, and *never* as related to, or descriptive of the continually changing lines.

In Tilden Reissued Patent No. 10,778, under which the Hersey meter is manufactured, Tilden employs

the term "contact lines" in precisely the same sense it is employed in the specification and claims of the Nash patent, and he explains that these lines must continually change their position to enlarge and contract the measuring chambers.

"that because of the shape of the wall of the chamber and of the piston, the piston is kept in contact with the wall of the chamber at a number of what I call "*contact lines*" which form the *changing* limits of measuring and discharging passages, spaces or recesses. The number of lines of contact depends, of course, upon the number of spaces or recesses. This separation or division of the chamber is necessary, because a full head is maintained in the larger part of the chamber, and it is of course necessary to divide the spaces or recesses or portions thereof, which are successively emptied from those which are being successively filled by fluid under pressure. This division is accomplished by contact of the piston with the wall of the chamber. The lobes, in connection with the portions of the wall which constitute or from the spaces or recesses, also act to separate the outlet ports from the inlet ports, so that each space or recess that is discharging is separated from the portion of the space that is filling by two contact lines—one between the outer surface of the lobe and the wall of the recess, and the other between the surface of the inward projection of the wall and the surface of the piston between the lobes. *These lines of contact continually advance* until the fluid has been expelled from each space or recess."

X.

WHY THE PATENTEE SPEAKS OF THE ORBIT MOTION AS BEING "ACROSS THE CENTRE" OF THE CYLINDER CHAMBER.

The question arises why, if the patentee meant by the term "eccentric or side-rocking" the orbit motion of the piston around the centre of the cylinder, he should also have spoken of it as being "across" the centre of the cylinder. There is no

difficulty in this if we stop to observe that the Nash pistons always cover the centre of the case. The orbit motion of these pistons is, therefore, not only *around* the centre of the case but it is also *across* the centre of the case. This is the sense in which the words are used throughout the specification and in the claims. Of course, in the same sense, defendants' piston has an orbit motion *across* the centre of the cylinder as well as *around* it.

XI.

DEFENDANTS' CONTEND THAT THE FIRST CLAIM OF THE NASH ORIGINAL PATENT SHOULD BE LIMITED BY IMPLICATION TO THE FOLLOWING ELEMENTS NOT IN TERMS REFERRED TO THEREIN.

(*a.*)

They contend that all the claims by implication are limited to a structure in which the piston is so much smaller than its case that it can revolve on its own axis while it is pursuing its orbit motion.

The passage in the specification on which they rely to support this contention, reads (Record, bottom of p. 96):

"The piston H is arranged for operation within the cylinder, and the bearing or contacting surfaces of these parts are formed by alternate recesses *a a'* and *b b'* of such form or configuration as to allow of the rotation of the piston not only upon its own axis, but around and across the centre of the cylinder, and the space within the cylinder must be of such form and sufficiently larger than the piston H to allow it to have this compound motion."

As defendants' piston is not in a case of "such form and sufficiently larger than the piston to allow it to have a compound motion" they say it does infringe."

This is only one of the differences between the Galloway Kinematic Engine and the Galloway Patented Engine. No part of Nash's invention resides in such feature.

Our reply to this contention is:

(1.) That the claim is not, as we have seen, limited to this feature, although it is shown in the drawings and described in the specifications. We have seen that this claim, if properly drawn, should not have been so limited, as this feature has nothing whatever to do with either of the functions of the piston. We are not acquainted with any decisions that hold that a claim should by implication be limited to a *purely incidental feature* shown in the drawings and described in the specification, when the claim is not by its terms so limited.

In *Winans* vs. *Denmead*, 15 How., 338, 341, the Supreme Court, speaking by Mr. Justice Curtis, said:

"Now while it is undoubtedly true that a patentee may so restrict his claim so as to cover less than he has invented, or may limit it to one particular form of machine, excluding all other forms, though they also embody his invention, yet such an interpretation could not be put upon his claims if it can be fairly constructed otherwise, and this for two reasons:

"1. Because the reasonable presumption is that having a just right to cover and protect his whole invention, he intended to do so.

"2. Because specifications are to be construed liberally, in accordance with the design of the Constitution and the patent laws of the United States to promote the progress of the useful arts, and to allow inventors to retain to their own use, not anything which is a matter of common right, but what they themselves have created.

"In the numerous cases in which it had been held that to copy the patentee's mode of operation was an infringement, the infringer has forms and proportions not described and not in terms claimed. If

it were not so, no question of infringement could ever arise. If the machine complained of were a copy, in form, of the machine described in the specification, of course it would be at once seen to be an infringement. It could be nothing else. It is only ingenious diversities of form and proportion, presenting the appearance of something unlike the thing patented, which give rise to questions; and the property of inventors would be valueless if it were enough for the defendant to say, your improvement consisted in a change of form; you describe and claim but one form; I have not taken that, so have not infringed.

"The answer is, my improvement did not consist in a change of form, but in the new employment of principles or powers, in a new mode of operation embodied in a form by means of which a new or better result is produced; it was this which constituted my invention; this you have copied changing only the form.

"Where form and substance are inseparable it is enough to look at the form only. Where they are separable; where the whole substance of the invention may be copied in a different form, it is the duty of the courts and juries to look through the form for the substance of the invention—for that which entitled the patentee to a patent, and which the patent was designed to secure. Where that is found there is infringement.

In the *Corn Planter Case*, 23 Wall., 181, 221, the defendant claimed that as the framework of their machine was not the framework described in the specification of the patent in suit, viz.:

"Without gearing, without spokewheels and other expensive fixtures, and resembling a drag or sled more than it does a carriage or wagon in its motion or general appearance."

The Court said:

"By this description Brown was evidently attempting to show how simply and cheaply the thing could be made, not that it was to be confined to that specific form. It might as well be contented that

he intended to confine his invention to wood, and that a machine made of iron or other metal, though made in precisely the same form, would not be an infringement. This, we think, is the fair meaning of his language when taken in connection with the whole specification. A literal construction is not to be adopted where it would be repugnant to the manifest sense and reason of the instrument."

(2.) Besides, it will be observed that the passage above quoted is a part of the description of the drawings in which the parts described are designated by reference letters. The description of the drawings is full and accurate, and this is required by law. The law does not require an inventor to omit from his specification all reference to the unessential features of the contrivance which he shows as an embodiment of his invention. That is required of him in the claims. On the other hand, it requires him to describe the contrivance so fully that anybody skilled in the art can make and use it (R. S., Sec. 4888). Neither does the law require the inventor in such description to use terms so vague and ambiguous that they would apply to every infringing structure; if it did it would require an impossibility.

Nevertheless, this patentee (although he was not required to do it), after describing the drawings, indicates that other forms than those shown may be used, for he says (Record, same paragraph, top of p. 97):

"*Of whatever form* these alternate recesses and projections they must be such that while they are in contact upon one side of the cylinder they must also at the same time have a contact at the opposite *or a different* side of said cylinder, and in this way divide the cylinder into spaces."

Precisely that is true of defendants' meter (see Plate V.).

(*b.*)

Defendants contend that this claim is limited by implication to a structure in which all the receiving spaces are on one side of the piston and all the discharging spaces are on the other side. This they allege is not true of their meter.

We submit that there is nothing either in the specification or the claims limiting it to this feature, but if there were defendants' meter would infringe, because it has the receiving spaces on one side of the piston and the discharging spaces on the other side in precisely the same sense and for identically the same purpose as Nash. If they were not so arranged the device would not be operative.

The only difference between the meters as regards the shape and arrangement of the measuring chambers is the difference between the Galloway Kinematic Engine and the Galloway Patented Engine. Nash's invention had nothing to do with the form and relation of measuring chambers, for his form and that adopted by Tilden were both old.

The object of having all the receiving spaces on one side and all the discharging spaces on the other is to make the piston move. In the common piston and cylinder the receiving space must be on one side and the discharging space on the other, otherwise the piston would stand still (see Plate I.). For precisely the same reason this arrangement is necessary in defendants' meter as well as in the Nash meter. An examination of Plate V will show that the receiving spaces of defendants' meter are on one side of the piston and the discharging spaces on the other side.

Indeed, defendants have followed the specific directions of Nash as to how to get the best results in this regard . He says (Record, p. 98, middle of page):

"It is required in order to get the *best* results, that the valve should open and close its inlet ports

PLATE XVIII.

——————— indicate "lines of pressure" in both figures

Fig. 1

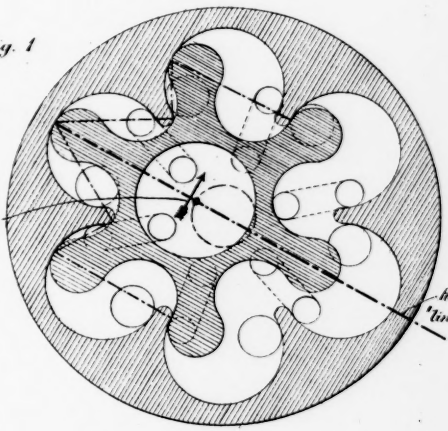
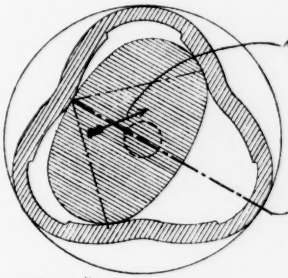


Fig. 2

Fig. 11 of patent in suit



Drawing showing that "line of motion" is "as nearly as possible" at right angles to the "line of pressure" in Defendants' Meter — much nearer at right-angles than in some of the figures of the patent in suit, fig 11, for example.

in succession in such a manner as to keep the line of pressure *as nearly as possible* at right angles to the direction of the motion of the piston. By 'line of pressure' I mean a line connecting the points of division which separate the inlet from the outlet spaces *c* of the cyclinder, as shown by the line *z* in Fig. 12; and by the 'line of motion" I mean a line which is tangent to the path of the axis of the piston at any point of such path, as shown by the arrow *y* in said figure."

In Fig. 12 of the Nash patent the "line of motion" is exactly at right angles to the "line of pressure;" but the same is not true of all the patent figures. Indeed, Fig. 12 is the only figure in which these lines are exactly at right angles. In Fig. 11, for example, it is impossible to make them at right angles; they are not even "as nearly as possible" at right angles, for the line of motion is not at right angles to the *resultant* of the lines of pressure (see Plate XVIII., Fig. 2).

The preferred form of the patent is, however, embodied in defendants' meter. Here it is impossible for the "line of motion" to be at right angles to *all* the lines of pressure, but it is as "nearly as possible" at right angles, that is to say, it is at right angles to the *resultant* of said lines (see Plate XVIII., Fig. 1).

Brevoort, Q. 87, Record p. 54 says:

"The patent describes the line of pressure as the line connecting the points of division *x x* which separate the inlet from the outlet spaces of the cylinder. Now, using it in that sense, the figures do not show this line of division across the diametrical centre of the meters in all the figures, but show it almost parallel in some and at different angles in others. In the defendants' meter the projections from the piston divide each of the cavities into outlet and receiving spaces, which division forms the line of pressure and the line of motion is at right angles to this line."

Defendants' counsel in the Court below laid great stress upon the fact that the reference letters "*c c*," referring to these receiving and discharging spaces, are used in the claim.

We are not aware that the use of reference letters in a claim is anything more than a reference to the drawings for specificness; and we have yet to learn that it imports into the claim every detail shown in the drawings so referred to- the incidental ones, as well as others. On so simple a point it can serve no good purpose to refer this Court to the innumerable cases in which it has found infringement where such a rule, if followed, would have let the defendant go free. Indeed, such a rule would make non-infringement of a lettered claim so easy that no sane man would ever infringe.

But even if any special limitation were placed upon the claim by the use of these reference letters "*c c*" defendants would infringe, for they use, as we have seen, the very arrangement recommended by Nash.

(*c.*)

Defendants contend that the claim is limited by implication to a structure in which the piston is in contact with its case on diametrically opposite sides at the same time.

This is a curious contention. It finds no support either in the drawings or the specifications of the Nash patent. The contact is not on *diametrically opposite* sides in Nash Figs. 10 and 11, for instance. Besides, the specifications do not say it must be. What they say is (Record, top of p. 97):

"Of whatever form the alternate recesses or projections, they must be such that while they are in contact upon one side of the cylinder, they must also at the same time have a contact at the opposite *or a different side* of said cylinder, and in this way divide the cylinder into spaces."

PLATE XIX.

Fig. 10 of patent in suit

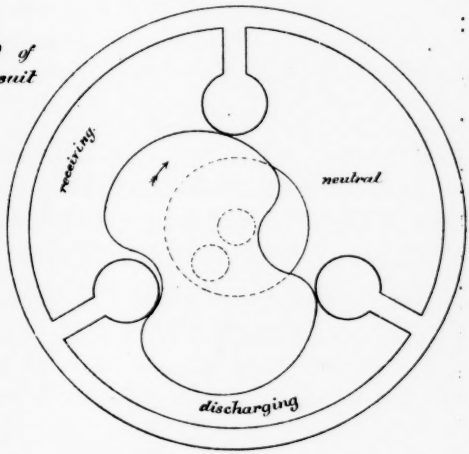
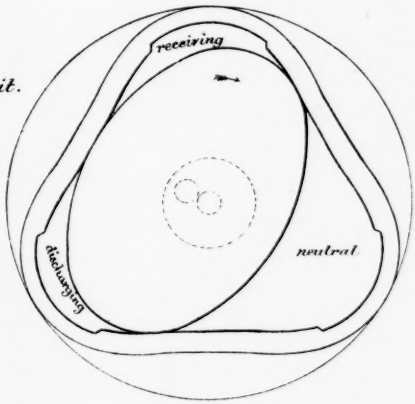


Fig. 11 of patent in suit.



Outline drawing showing neutral chambers in figs 10 & 11 of patent in suit.

The piston of defendants' meter has contact on "*different sides.*" Indeed, it even has contact on *opposite* sides.

Whatever insignificant differences may be pointed out between the two structures may be also found on comparison of Galloway Patented Engine with his Kinematic Engine. The differentiating features are not new with Nash or Tilden.

(*d.*)

Defendants contend that they do not infringe because they employ the pressure present in the neutral chamber of their meter to keep the piston always in contact with its case; while Nash does not employ his neutral chamber for that purpose.

This again is only one of the differences between the Galloway Kinematic Engine and the Galloway Patented Engine. Neither Tilden nor Nash invented either form.

A neutral chamber is one which, for the instant, is neither enlarging nor contracting, and, hence, plays no part in the measurement of water.

In the first place, it is to be observed that the meters shown by Nash have one or more neutral chambers, hence, as far as the possession of neutral chambers is concerned, there is no distinction between complainants' and defendants' meters.

This is admitted by defendants' expert (Record, p. 180), where he says, referring to the patent in suit:

"Mr. Brevoort says, and says truly, that at times one or more spaces is neutral, that is, neither receiving or discharging."

In the positions shown in the Nash drawings the neutral chambers of Figs. 3 and 9 are at the top; the neutral chamber of Fig. 10 is at the right; the neutral chamber of Fig. 11 is at the right. (See Plate XIX.)

All defendants' counsel can say is that in their meter the presence of a neutral chamber is necessary, while in our meter it is not. Even this distinction is true only in a sense, and whether true or not it is immaterial.

The fact about it, however, is this:

The shape of the piston and chamber in defendants' meter is such that the piston is not necessarily held in contact with its case. Of course, it could be held in contact by journals and bearings, but they prefer to use that feature devised by Nash and covered by the third claim of his reissue (which Tilden said in the paper read by him before the Boston Society of Civil Engineers (Record, p. 83) constituted "a step of great importance in the art"), to wit, a piston "moving within its case dependent upon no journals or bearings." As their piston has no journals or bearings it must be held up to its case in some other way and pressure in the neutral chambers does this. Pressure in the neutral chambers operated in the same way in the Galloway Patented Engine.

In the Nash meter when the piston is new it fits the case so snugly that it is not necessary to use either journals or bearings, or the pressure in the neutral chamber to hold it up to its case; but when it is old and worn smaller the pressure in its neutral chambers will do that very thing.

There is absolutely nothing in the specifications or claims limiting the patent to any such feature. It is not a feature peculiar to a piston that does not revolve on its axis. Defendants' piston in case M that revolves on its axis shows the same feature (see Plate XV.). It is incidental purely in any form and no more to do with the question of infringement than the color the meter case is painted.

PART IV.

DOES DEFENDANTS' METER INFRINGE CLAIMS 3, 4, 5 AND 6 OF THE NASH REISSUE PATENT?

I.—Infringement of Claim 4 discussed.

II.—Infringement of Claim 5 discussed.

III.—Infringement of Claim 6 discussed.

IV.—Infringement of Claim 3 discussed.

V.—Law points on Question of Infringement.

I.

CLAIM 4 OF THE REISSUE IS NOT ANTICIPATED AND IS INFRINGED.

Claim 4. "A piston for water meters, pumps and motors, having alternate bearing points or projections and recesses, adapted by means of a cylinder chamber having alternate bearing points or projections and recesses to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, *said piston having a free movement within said cylinder, controlled only by the shape of the cylinder, the shape of the piston and the flow of the water through the meter.*"

The words in italics were added to original claim 1 by reissue. The word in roman comprise the whole of original claim 1.

The question of infringement is plain. Tilden, in his patent on defendants' meter, says (Record, p. 145):

"The piston's movement and its contact result, *not* from *mechanical* means, but from *hydraulic action of the fluid passing through the meter.*"

It is maintained on behalf of defendants that the British patent to Galloway, No. 11,485 of 1846, which we have before referred to, has a free piston controlled only by the shape of the piston, the shape of the cylinder and the flow of the water through the meter.

Mr. Brevoort's opinion on this question is found Record, pp. 41 to 43.

Mr. Tilden, when he wrote Exhibit Tilden Article (Record, pp. 79 to 84), was unquestionably in a position to know whether this piston moving freely as

described in the claim constituted an advance of any value in the art, as he had not only practical experience but had made the matter subject of especial study. He was also in a position to know whether from a practical as well as a theoretical standpoint the Galloway engine disclosed the features described in the fourth claim of the reissue.

Tilden knew of the Galloway patent as early as May, 1886. He had carefully studied the patent before September 30, 1886, since on that date he filed his application for a reissue of his own patent, which reissue, he says, was made necessary by the discovery of the Galloway patent. The Tilden article was read before the Boston Society of Civil Engineers on November 17, 1886, and was written about the time it was read.

Tilden, x-Q. 24 to x-Q. 27, Record, pp. 217 and 218.

This Tilden article was, therefore, written at the very time he was at work, or immediately after he had finished work on the reissue of his patent, the specification of which was entirely rewritten, as he states in the affidavit filed in the Patent Office accompanying the application for reissue, in view of the Galloway patent (Record, p. 296).

There can be no pretense, therefore, that at the time he wrote the Tilden article he did not have in mind the Galloway patent.

The statements contained in this article, he says, he believed to be true at the time he wrote them. At that time he thought that a piston combined with its casing "in such a manner that the piston may move within its casing dependent upon no journals or bearings" constituted a "*step of great importance*," and that it was a very different thing from a piston having journals and bearings like Galloway. This "step of great importance" is the very feature covered by the 4th claim of the patent in suit.

Tilden says (Tilden Article, Record, p. 83):

"A *step of great importance* has been taken in the combination of a casing and one piston in such manner that the piston may move within its case *dependent upon no journals or bearings.* The effect of this is so far to reduce friction and increase operative areas as to bring the meter within a very small compass."

Nash was the person who first took this "step of great importance." The meter described in the paragraph quoted is the "Crown," manufactured by complainants under the patent in suit (Brevoort, RD-Q. 245 and 246, Record, p. 74).

The difference between a structure which has a free and uncontrolled piston and one which has not, is seen by comparison of defendants' meter with Defendants' Exhibit Galloway Machine. In the Galloway engine the piston carries its upper head-plate, and is hampered in its movements by the friction between this head-plate and the upper surface of the cylinder. It has a journal entering a hole in the piston provided with a spring which constantly keeps its journal bearing tight, and which gives the maximum friction which can be had between the piston and its journal bearings. The spring also pushes the piston against the walls of the case, and this very materially increases the friction between the piston and its case. This is true of the spring which the model now has, but this spring is not as strong as the engine requires to perform the functions which Galloway describes. To be of any use in the device, it must be strong enough to move the piston, and this, Mr. Brevoort says, it will not do even when the parts are greased. The present spring could have no useful function in the Galloway engine, and the only function it could perform would be to increase, by the strength of the spring, the friction on the journal and between the piston and its cylinder walls.

The object of the improvement set forth in the fourth claim of the reissue in suit is, in a word, to avoid friction.

Mr. Tilden in his article tells us that—

"Friction and consequent wear and inaccuracy have been an almost insurmountable obstacle in the path of a small piston rotary."

The advantages derived by avoiding friction are: (1) Increased head or pressure to the water passed through the meter; (2) the life of the meter is increased and the necessity for repairs diminished; and (3) the accuracy of the meter is improved. These advantages we will consider separately.

(1.) *Decreasing friction increases the pressure of water delivered.*

Mr. Tilden points out, in his article, that to be efficient a meter "must not materially or noticeably retard the flow or diminish the pressure" of the passing water. At another place he says, "the introduction of a meter on a pipe must not reduce or affect the pressure." These statements are true, and it is a matter of the greatest importance to both the department and the consumer.

A loss of head or pressure simply means just so much work done by the water in the meter, and therefore the less the work done the less the loss of pressure. Practically, the only work to be done in a meter is to overcome the friction of the working parts, and hence the less friction there be in the working parts the less loss of pressure there will be.

Now, by making a piston independent and free from all other parts and controlled only by the shape of the piston, the shape of the cylinder and the flow of water through the meter, the work to be done in the meter by the passing water is greatly diminished. The friction between the pistons and its jour-

nals and bearing is entirely eliminated. The piston is not hampered by carrying any other part, and the friction between the surface of the piston and the walls of the case is reduced to the minimum. Everything that can tend to increase the work done in the meter by the water is eliminated. The only point at which there is any friction is between the walls of the piston and its cylinder, and here the friction is as little as possible.

(2.) *Decreasing friction increases the life and durability of the meter.*

Mr. Tilden also points out in his article that—

"to be efficient a meter must be accurate within a permissible error, under extremes of pressure and rates of flow, of perhaps two per cent., in favor of either the department or the consumer, and must maintain this standard with a reasonable, or rather an unreasonable, degree of permanency." It must be "inexpensive in repairs, and capable of standing abuse, rather than use."

This is a question which also affects both the department and the consumer, for when a meter through wear becomes inaccurate it is worse than useless.

Wear results from friction. As friction is diminished, wear is correspondingly diminished. By the invention set forth in the fourth claim the moving part, which is the piston, is made as simple as possible, is relieved of the burden of carrying other parts, is deprived of journals and bearings and the friction between the piston and its case reduced to the minimum. Journals and bearings are bound to wear, and to wear faster in a meter than in other devices where lubricants may be employed. The meter of this claim avoids the use of these parts which are subject to wear, and by reducing friction to a minimum consequent wear is also reduced to a minimum.

(3.) *Decreasing friction increases the accuracy of the meter.*

A free piston controlled only as described in the claim makes not only a more durable but a more accurate measuring device. In order to decrease friction to the minimum, the piston should be loosely fitted between the cylinder head plates so that a film of water may intervene and act as a lubricant.

The looseness of fit of the pistons of both complainant's and defendants' meters is very strikingly illustrated by the test which Mr. Brevoort made and which he described in his answer to question 19 (Record, p. 42). He found that when the pistons were blocked, so that they could not move, about one-third to one-quarter of the water the meter would pass with a full stream and an unobstructed piston, passed through them. He thus demonstrates the fact that the pistons in both meters are very loosely fitted and to the same degree. With pistons fitted as loosely as these are, and must be to obtain the best results, it will be very readily understood that a considerable quantity of water would constantly leak by the piston if the piston did not move easily.

Water flowing through an aperture encounters resistance, which is known as water friction, and which increases as the size of the aperture decreases. Every one has noticed that a stream at its centre flows faster than at its sides. This is due to the friction between the water and the banks of the stream. Flowing water divides itself between two paths in inverse proportion to their respective resistances. Hence, decreasing the resistance in one line is equivalent to increasing it in the other. If the piston of the Nash meter moved without any friction whatever absolutely no water would leak through unmeasured. By decreasing the friction to the minimum the maximum accuracy is obtained and

the difference between the amount which leaks through under the heaviest and the lightest pressure is so small as to be unnoticeable.

Mr. Brevoort says (Q. 19, Record, p. 43):

"With pistons fitted so freely the water would leak around were it not for the fact that when the water attempts to leak the piston prefers to move rather than let the water pass it, and thus the freedom of the movement of the piston is a cure for what would naturally be supposed to be a serious source of leakage."

The freedom of the piston is, therefore, an element which improves the accuracy of the device as a meter as well as increases its durability and efficiency.

The state of the art shows neither an engine nor a meter having a piston which moves within its case dependent on no journals or bearings before the date of the Nash patent. This feature is absolutely new not only in the meter art but also in the engine art. The nearest approach to it is in the Galloway, 1846, British patent, and there we have seen that the spring introduced in a shaft, instead of reducing friction between the journals and its bearing, increases it, and that it also increases the friction between the piston and its case walls. Besides, the piston of the Galloway 1846 patent carries the upper head-plate of the case bolted to it and is hampered in its movements by the weight of this plate and its friction with the top of the cylinder.

This structure is specifically disclaimed in the reissue.

Defendants do not employ the structure shown in the Galloway 1846 patent, but they use the precise structure which Nash invented, and which Tilden says constitutes a "step of great importance" in the art.

II.

THE FIFTH CLAIM OF THE REISSUE DESCRIBES A NOVEL COMBINATION OF ELEMENTS AND IS INFRINGED BY DEFENDANTS.

Claim 5. "A piston for water meters, pumps and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking motion within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, *said piston being formed of hard rubber and having a free movement within said cylinder controlled by the shape of the piston, the shape of the cylinder, and the flow of water through the meter.*"

The words in italics were added to the original claim 1 by reissue. The words in roman comprise the whole of original claim 1.

We have already discussed and are familiar with the object of avoiding friction in the working part of a meter. The specific gravity of hard rubber very nearly approaches that of water. The piston has not only a free motion controlled by the shape of the cylinder, the shape of the piston and the flow of water through the meter, but the piston is a *floating* piston. It floats around in the stream (completely surrounded by water in its loosely fitting case) and offers practically no impediment to its passage. Here we have the ideal condition for a structure where ease of movement and avoidance of friction is of paramount importance. The piston carries no unnecessary part with it. It has no journals or bearings. It moves with the least possible friction against the case walls while maintaining the necessary contact, for it is controlled altogether

by the current of water passing through the meter. It is made of a substance which readily floats in the stream and will respond to the slightest movement of the water without interfering with its passage.

The scope of the claim must be clearly understood. It is not broadly for a rotary piston made of hard rubber. If it were, it would be anticipated by the patent to Read and also by the patent to Fitts, both of record. It is not for a piston of the Galloway type made of hard rubber. *The claim is for the free and uncontrolled piston of the fourth claim made of hard rubber.*

Even if such a free and uncontrolled piston were old, it would require invention, even in view of Read and Fitts, to make such a piston of hard rubber, for Mr. Tilden admits that the conditions differ in different meters (Record, p. 218).

"Q. 30. Is there any advantage in the use of hard rubber because it is lighter?

"A. In some meters, yes; in some, no."

The scope of the fifth claim renders it unnecessary at length to discuss the Read or Fitts patents. We have seen that the free and uncontrolled piston of the fourth claim without any journals or bearings is generically novel. The combination of elements set forth in the fifth claim is therefore novel without the hard rubber element. If the claim is for a proper combination of elements, and not for a mere aggregation of disassociated parts, there can be no question as to its validity. That the element of hard rubber forms a legitimate combination with a free and uncontrolled piston to produce a useful result, there can be no possible doubt.

It does not lie in the mouths of defendants to deny the utility of the invention, for they employ it part for part. Tilden has thought it worth his while to deny that he uses hard rubber on account of its lightness, which makes it a floating piston. The

denial is of no consequence, for in his article he says, referring to his own meter (Record, p. 84):

"An illustration is found in a meter" (the Hersey) "in which the piston—which is made of hard rubber *on account of its lightness* and great durability—moves in a circular path, but does not in any sense rotate on an axis real or imaginary."

On the question of infringement, Mr. Brevoort says (Record, p. 20):

"The fifth claim is for the same combination of parts, but involving a piston made of hard rubber. The piston in the Tilden meter is made of hard rubber; and all the benefits that flow from the use of such a piston in the Nash meter is had by Tilden meter, and consequently the Tilden meter contains the invention of the fifth claims."

III.

CLAIM 6 OF THE REISSUE IS INFRINGED AND IS NOT ANTICIPATED.

Claim 6. "A piston for water meters, pumps and motors, having alternate bearing points or projections and recesses adapted by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, *combined with ports controlled by said piston itself in its motion within said chamber.*"

The words in italics were introduced by reissue. The words in roman comprise the whole of original claim 1.

Here, again, infringement is clear. Tilden, describ-

ing defendants' meter in his patent, says (Record, p. 146):

"The piston performs a *double* duty; it not only acts to form measuring spaces and to discharge their contents, but the *portions thereof which cover the outlet ports also act as the valves* of the piston in that they serve alternately and in successive order to valvularly *control* or *open and shut* the outlet ports."

In prior engines and meters the ports were controlled (that is, were open and shut) by valves which were independent of the piston. It is a peculiarity of the Nash meter and of defendants' meter that the piston itself acts as the valve which opens and shuts the ports. The portage of the Nash meter can be conveniently studied in the skeleton model Nash meter. Referring to this, it will be seen that there is a polygonal central hole in each end plate. It will also be observed that the piston has in it several crooked passages terminating at one end in a cluster of oval holes around the spindle and terminating at the other end on the sides of the piston between its points. Water enters at the bottom of the meter and goes out through the top. In whatever position the piston stands some of these outlet ports at the top of the piston and some of these inlet ports at the bottom of the piston are open—that is, are uncovered, being within the central polygonal hole in the head-plate. If a straw be pushed through the parts that are open at the bottom it will be found that they lead to the enlarging chambers, and if one be pushed through the ports which are open at the top it will be found that they lead to the contracting chambers. This is true of every position of the piston. In this way the piston is relieved of the burden of carrying or of operating a separate valve. The piston itself opens and closes the the ports—that is, the piston itself acts as its own valve. Nash was

the first to make a piston either in a water meter, pump or engine having this function.

The portage of defendants' meter may be conveniently studied in Exhibit D (Plate XVI.), or still better with the wooden piston R in the wooden case O. The piston has a central cavity corresponding with the polygonal hole in the upper head-plate of the Nash meter. The larger holes in the bottom head-plate are inlet ports and the smaller communicating holes or grooves are outlet ports. The inlet ports are in succession covered and uncovered with the lobes of the piston. The outlet ports are in succession covered and uncovered by the central cavity in the piston. The outlet ports which are inside of the central cavity of the piston are open and those which are covered by the piston or are outside of the central cavity are closed. In any given position of the piston it will be seen that the chambers that are enlarging have the inlet ports open and outlet ports closed, and that the chambers that are contracting have the outlet ports open and the inlet ports closed. This is true of every position of the piston. In this way the piston is relieved of the burden of carrying or of operating a separate valve. The piston itself opens and closes the ports—that is, the piston itself acts as its own valve, just as it does in the Nash meter.

In both these devices, therefore, the ports are controlled (that is, they are open and shut so that water will pass intermittently through them), by the piston itself. The piston is the valve in both devices.

This is the feature which is covered by the sixth claim of the patent in suit.

In discussing this claim, Mr. Renwick has criticised the use of the term "ports" in the patent. The patent calls the holes in the end plates and also the holes in the end of the piston all ports. Mr. Renwick says that the holes in the ends of the piston are the

only ports in the device, and that the holes in the end plates are valves, because these open and shut the ports.

Mr. Brevoort defends the use of the term as employed in the patent, and insists that the holes in the end plates, as well as the holes in the piston, are properly called ports. He says that even if the end plates do act as valves, nothing is more common in mechanics than for a valve to contain ports, as does the ordinary slide valve, a drawing of which he produced (Brevoort, Q. 28 and 29, Record, p. 45).

This difference of opinion as to what should or should not be called ports is quite immaterial, in view of the fact that there is and can be no misunderstanding as to what the patent calls ports. It is essential, however, in reading Mr. Renwick's testimony, to bear in mind the distinction which he makes for a proper understanding of it.

In all these structures, defendants' as well as complainant's, there must be a plurality of separate passages leading to the receiving and discharging spaces and each passage must be "separate and dis- "tinct from all the others and be capable of being "closed or opened irrespective of the fact whether "the others are closed or opened," otherwise the machine will not work (Renwick, Record, p. 182). The same is true of the Hersey meter (Renwick, x-Q. 37 and 38, Record, p. 197). In both, the ports in the piston are concentric with the piston, and the ports in the case are concentric with the case. We have seen that it is the eccentric position of the piston that opens and shuts the proper ports.

Between the Skeleton Model Nash Meter and defendants' meter there is this difference: In the Skeleton Model Nash Meter the plurality of separate exhaust passages leading to the measuring spaces are in the piston, and these operate in connection with one large central opening in the head-plate (see Fig. 2,

Plate XX.). In the defendants' meter the plurality of separate exhaust passages leading to the measuring spaces are in the head-plates, and these operate in connection with one large central opening in the piston (see Fig. 1, Plate XX.). In both there is a large central opening, and in both there are a plurality of separate passages leading to the measuring spaces, and these in both act in conjunction for the same purpose. In one the central opening is in the moving part. In the other the central opening is in the stationary part (Brevoort, Q. 30, Record, pp. 45 and 46).

In thus turning the structure around, Tilden did no more than Nash had already done. In the complainants' commercial meter known as the "Crown" (see Fig. 2, Plate XXI.), the plurality of separate ports are in the head plates, and the central port is in the piston. The exhaust portage of the Hersey meter is obviously a substantial copy of the exhaust portage of the Crown meter.

Mr. Renwick admits that in defendants' meter the "ports are controlled by the piston itself in its motion within the chamber" (x-Q. 36, Record, p. 197).

"36 x-Q. You have testified that in your opinion the Hersey meter contains certain ports in its end plates. Are not these ports in that meter controlled by the piston?

"A. Yes; and I in substance said so in my direct-examination."

Defendants contend that the claim is limited to a structure in which the *piston* contains separate passages leading to the measuring chambers, and the *head plate* contains the large central hole which opens and shuts these passages or ports, as distinguished from a structure in which the head plates contain the separate passages leading to the measuring chambers, and the piston contains the large central hole which opens and shuts them.

PLATE XX

Exhibit Y.

Fig. 1

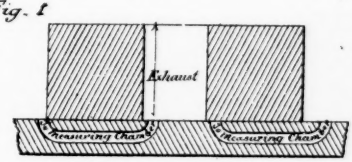


Fig. 2

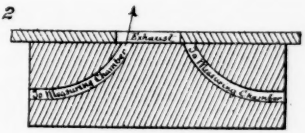


Fig. 1 shows system of exhaust in Defendants Meter

Fig 2 shows one system of exhaust in Patent in suit

PLATE XXI

Fig 1

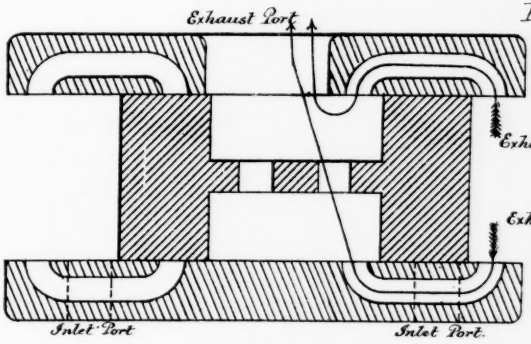


Exhibit N-O.

Fig 2

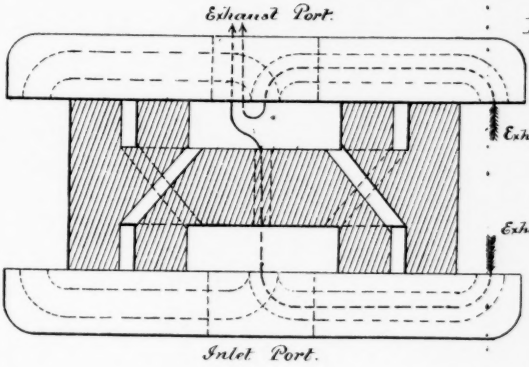


Exhibit P-S.

Fig. 1 shows system of Exhaust in Defendents Meter

Fig. 2 shows system of Exhaust in Crown Meter

Of course there is no such limitation in the claim. Looking back to the specification we find that it repeatedly emphasizes the fact that the patent is not limited to the precise form of ports shown.

Thus the patent says, at the bottom of the page 95, after describing the different forms of valves shown:

"But the result of these different arrangements of valves is identical and any suitable form of valve may be used that will operate with a periodic relation to the movements of the piston."

And again towards the bottom of page 97:

"I do not wish to confine myself to either of the specific arrangements of the valve shown, or to any specific construction of valves in relation to the piston, so long as the valve and piston co-operate to produce the results stated."

And again at the top of page 99:

"An important feature of my invention embraces the combination with a piston adapted to operate substantially as described, of a valve controlled thereby, irrespective of its specific construction or arrangement."

So there is no basis in the specification for the limitation which defendants seek to import by implication into this claim.

The experts on both sides agree that when the claim says the ports are "controlled" by the piston it means that the piston *opens and shuts* them, so that water will intermittently flow through them.

Brevoort, x-Q. 254, Record, p. 77.
Renwick, x-Q. 31, Record, p. 196.

The facts in this case are curiously similar to those presented to this Court in Consolidated Valve Co. *vs.* Crosby Valve Co., 113 U. S., 157, where Mr. Justice

Blatchford, comparing the patented device and the infringing device said, (p. 178):

"In the Richardson valve the valve proper is a disk and the extended surface is an annulus surrounding the disk, while in the defendant's valve the valve proper is an annulus and the extended surface is a disk inside of the annulus. But this is a mere interchange of form between the valve proper and the extended surface within the skill of an ordinary mechanic * * * In the Richardson valve all the steam which escapes into the open air escapes from the huddling chamber through a stricture which is smaller than the aperture at the ground joint. In the defendant's valve the valve proper has two ground joints. One at the inner periphery of the annulus and the other at its outer periphery, and only a part of the steam, namely, that which passes through one of the ground joints, passes into the huddling chamber and then through the stricture. The other part of the steam passing directly from the boiler into the air through the other ground joint. But all that part of the steam which passes into the huddling chamber and under the extended surface passes through the constriction at the extremity of such chamber in both valves, the difference being only one of degree but with the same mode of operation * * * In defendant's valve the huddling chamber is at the centre instead of the circumference, and is in the seat of the valve under the head instead of in the head, and the stricture instead of being at the circumference of the head is at the circumference of the seat of the valve, but this is only the use of means equivalent to those shown by Richardson, while the mode of operation of the parts of the mechanism is the same in their relation to each other and the result is the same."

(P. 171:)

"Taught by Richardson, and by the use of his apparatus, it is not difficult for skilled mechanics to take the prior structures and so arrange and use them as to produce more or less of the beneficial results first made known by Richardson; but prior to 1866, though these old patents and their descriptions were accessible, no valve was made producing any such results."

(P. 171:)

"When the ideas necessary to success are made known and a structure embodying these ideas is given to the world it is easy for the skilful mechanic to vary the form by mechanism which is equivalent, and is, therefore, in a case of this kind, an infringement."

(P. 172:)

"This was a problem of the reconciliation of antagonisms which so often recurs in mechanics and without which practically successful results are not attained. * * * This problem was solved by Richardson and never before."

Ortleib Engine.

The Ortleib patent has no valve and the ports are "not controlled."

We have had an illustrative model of this Ortleib model made and it is marked in evidence, Exhibit X.

The three holes in the case are in effect a single passage with two bridges thrown across it. (See Plate XXII.) They are precisely the same in operation as the larger holes through the outside case and they are *never closed* in any position of the piston. The fluid constantly passes through them, and does not intermittently pass through them, as is the case of complainants' and defendants' structures. In this device we do not find a plurality of separate inlet and outlet ports, some of which are open and some closed at all times by the piston, which we have seen is essential to both complainants' and defendants' structures.

Concerning this Ortleib engine, Mr Brevoort (Q. 31, Record, p. 46):

"I have read the patent and I have caused an illustrative model to be made, which I now produce (Exhibit X.).

"It will be seen that by operating this model the ports are always open. The ports that let in and

exhaust the steam from the boiler are made up of three holes, each leading into one passage, while the ports of the low pressure chamber are made, not of holes, but of a single slot, and the three holes above referred to might as well be cut into one. The piston sweeps over the ports in the operation of the engine, but the piston never closes the ports, and consequently I disagree with Mr. Renwick, and I do not think that the Ortleib patent shows a device having ports which are controlled by anything."

Brevoort (x-Q. 193, Record, p. 68):

"The three holes in the end of the case of the Ortleib engine are merely one port with two bridges across, and this port, for it is really one port, is never closed, and steam is flowing through it continuously, and therefore it is not controlled."

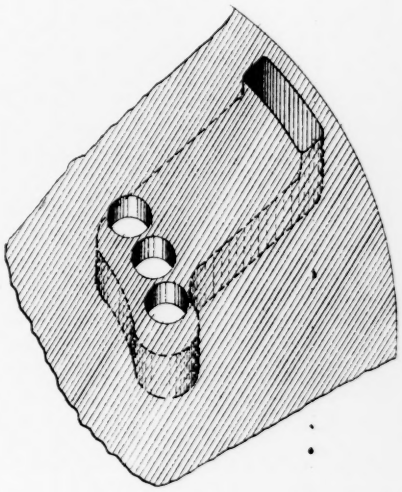
The operation of the piston in the Ortleib patent is substantially identical with the operation of a water wheel. In both the fluid constantly passes through the inlet and outlet passages, one chamber after another advancing into position to be filled, and then to the position to be emptied; and neither the water wheel nor the Ortleib engine have any valves.

IV.

DEFENDANTS' METER INFRINGES THE THIRD CLAIM OF THE PATENT IN SUIT.

Claim 3. "A piston for water meters, pumps and motors *provided with internal water passages*, and having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c*, *c*, which communicate with the inlet and outlet."

PLATE XXII.



Perspective of outlet passage of Ortlieb Engine, showing that the three holes are a single passage with two bridges thrown across it — which passage is never closed by the piston.

The words in italics were added to the claim by reissue. The words in roman comprise the whole of original claim 1.

On the question of infringement Mr. Brevoort thus testifies (Record, bottom of p. 17):

"Turning to the (3d) third claim I find that a piston is described which is provided with internal water passages. This is a feature of great advantage, particularly in a meter, as it admits of the passage of the water through the piston, which feature both increases the capacity of the mechanism and tends to simplify the valve arrangement when the piston itself forms the valve, opening and closing the ports by its own movement."

Brevoort, Record, middle of p. 20:

"The third claim is for a piston in a meter of the description referred to, provided with internal water passages. A glance at the Tilden meter shows that the piston is provided with internal passageways down through which a part of the exhaust takes place. I have not omitted to take into consideration the fact that in the Nash meter some of the passageways are used as 'outlets' and some as 'inlets,' while in the case of the Tilden meter the passageways in the piston are only used for the exhaust or outlet, but, nevertheless, there is no doubt in my mind that the invention of the said third claim is found in the Tilden meter."

There is no doubt but that the piston of the Hersey meter has internal water passages and that it comes within the scope of the third claim.

Chapman Engine.

But defendants seek to limit the scope of the claim by showing that the combination of devices employed by defendants are old in Chapman, and therefore, if the claim were construed broad enough to include defendants' structure, it would be bad for want of novelty.

But the Chapman device is not in any sense a structure analogous to either complainants' or defendants' meters, and no possible construction of the claim could make it cover the Chapman engine.

A small wooden model of the Chapman piston and cylinder is in evidence.

The claim is not broadly for a piston having internal water passages, but it is for a piston and case having certain characteristics combined with internal water passages, which confer upon the structure functions which the Chapman engine has not and cannot have.

We have seen that the piston of both complainants' and defendants' meters act as valves to cause the water to intermittently flow through the entrance and discharge ports into the measuring spaces. This is accomplished by the co-action of the ports in the piston with the ports in the case. In both meters one set of these ports is in the piston and these are the internal water passages of the claim. In both cases, therefore, the internal water passages in the piston co-act with the passages in the case to confer upon the piston the function of acting as its own valve.

In the Chapman engine the steam passage through the piston does not co-act with any ports in the case to confer upon the piston the function of acting as its own valve. Indeed, the Chapman engine has no valves. The passage through the Chapman piston is, therefore, in no sense analogous to the passages through the Hersey piston.

On this point Brevoort says (Record, p. 48):

42 Q. Do you agree with Mr. Renwick that if this third claim be constructed broad enough to cover defendant's structure it would also cover the structure described in the Chapman patent?

A. I do not agree with Mr. Renwick. The meter of the defendants' has a piston which controls ports by reason of its movement of translation, as in the

patent in suit, while Chapman has no such construction.

43 Q. Do the internal water passages in the pistons of the meters of the patent and the defendants' meter co-operate with ports in the head-plate, to confer upon the piston the function of acting as its own valve?

A. Yes.

44 Q. Does the internal water passage of the piston in the Chapman structure co-operate with any ports, to confer upon the piston the function of acting as its own valve?

A. The piston in the Chapman structure does not co-operate with any ports, and the piston does not act as its own valve.

45 Q. Do you regard the water passages in the piston of defendants' meter as the substantial equivalent of the water passages in the piston of the Chapman structure?

A. No, I do not.

46 Q. What would be the effect upon the operation of the defendants' meter if the holes through the central web of the piston of the defendants' meter were stopped?

A. It would operate as before, but would not deliver as much water unless an extra exhaust pipe were added.

The internal water passages consist not only of the holes through the web but also of the cavities at each side of that web. If the holes in the web were stopped up the piston would still contain the internal water passages of the claim (Brevoort, Record, p. 74).:

244 R-D. Q. You have testified that if the central web of defendant's piston were made solid the meter would still operate; would the piston still contain "internal water passages" after the web had been made solid, in your opinion?

A. It would, undoubtedly.

Here again defendants have simply copied the construction of the Nash commercial meter, the

Crown, as will be apparent on an examination of Plate XXI. There is no doubt but that the water passages of the third claim are in the "Crown" meter, and no doubt but that they are also in defendants' meter, which is a servile copy of the "Crown." The only difference between the two is that in the "Crown" the water passes twice through the piston while in defendants' meter it passes only once.

V.

Law Points on Question of Infringement.

(*a.*)

The office of the specifications is distinct from that of the claim. The specification is to instruct those skilled in the art how to practice the invention of the claim in its preferred form. The claim is to inform the public what the thing is of which the patentee claims to be the inventor.

The object of the specification is to enable other persons skilled in the art to practice the invention covered by the claim. The only question is, can such a person, working by the specification and drawings, put the invention into practice without invention of his own. The law does not require the patentee in his specification to describe the particular structure used by defendant, nor does it require or encourage him in describing the structure shown to use language so vague that it will fit all other equivalent structures or any other equivalent structure. If it did few patents would be of any value and no question of infringement could ever arise.

Cochrane vs. *Deemer*, 94 U. S., 779, 789.
Machine Co. vs. *Murphy*, 97 U. S., 120, 123.
Ives vs. *Hamilton*, 92 U. S., 426, 430.
Winans vs. *Denmead*, 15 How., 338, 342.
Corn Planter Case, 23 Wall., 181.

Patentees sometimes add to their claims an express declaration to the effect that the claim extends to the thing patented, however its form or proportion may be varied. But this is unnecessary. The law so interprets the claim without the addition of these words.

Winans vs. *Denmead*, 15 How., 330.
Yale Lock Co. vs. *Sargent*, 117 U. S., 536.

(*b.*)

The Supreme Court has by the decisions in *Miller* vs. *Brass Co.*, *Mahn* vs *Harwood*, *Campbell* vs. *James*, and other cases, has laid great stress upon the fact that a claim for a number of elements in combination is in law a specific and solemn declaration that the combination of any number of those elements less than the whole is not covered by that patent.

The converse of this proposition is that a claim for a combination of elements less than the whole number described in the specifications is a specific declaration that the elements described in the specification, but omitted from the claim, are not essential to the inventions covered.

It is not, therefore, true that the patent in suit contains no intimation that the revolution of the piston around its own centre is a feature that may be dispensed with, because that element is not found in the claims on which infringement is alleged.

A claim for a given number of elements in combination is, therefore, (1) an admission that a combination of elements less than the whole is not covered by the patent; and (2) a declaration that features described in the patent, and not included as elements in the claim, are not essential features of the invention.

(c.)

The rule of law is well settled that the claim not only limits but defines the invention. The specification serves to show how that invention may be practiced. In construing the patent the specification is consulted only to correctly interpret the terms employed in the claim; not to alter or contradict them. The only exceptions to this rule are found (1) in those cases where the claims, in view of the state of the art, are too broad and must be limited by the specification to save the patent, and (2) when the specification contains what is in terms or in effect a specific disclaimer of territory which might otherwise be covered by the claim.

In *White* vs. *Dunbar*, 119 U. S., 47, 51, Bradley, *J.*, says:

"The context may undoubtedly be resorted to, and often is resorted to, for the purpose of better understanding the meaning of the claim, but not for the purpose of changing it and making it different from what it is. The claim is a statutory requirement, prescribed for the very purpose of making the patentee define precisely what the invention is. * * * This has been so often expressed in the opinions of this Court, that it is unnecessary to pursue the subject further; quoting *Keystone Bridge Co.* v. *Phœnix Iron Co.*, 95 U. S., 274, 278; *James* v. *Campbell*, 104 U. S., 356, 370."

In *Railroad Company* v. *Mallon*, 104 U. S., 112, 118, Wood, *J.*, says:

"In reference to this latter part of the specification (the claim) this Court, speaking by Mr. Justice Bradley, has said: It is well known that the terms of the claim in letters patent are carefully scrutinized in the Patent Office. Over this part of the specification the chief contest generally arises. It defines what the Office, after a full examination of previous inventions and the state of the art, determines the applicant is entitled to (Burnes *v.*

Meyer, 100 U. S., 671). In view, therefore, of this statute, the practice of the Patent Office, and the decisions of this Court, we think that the scope of letters patent should be limited by the invention covered by the claim, and that though the claim may be illustrated, it cannot be enlarged by the language used [illegible] parts of the specification. We are, therefore, justified in looking at the "claim" with which the specification of appellee's invention concludes to determine what is covered by his letters patent."

In *Brooks* vs. *Fiske*, 15 How., 213, 215, Catron *J.*, says:

"The claim, or summing up, however, is not to be taken alone, but in connection with the specification and drawings; the whole instrument is to be construed together. But we are to look at the others only for the purpose of enabling us correctly to interpret the claim."

(*d.*)

There can be no doubt but that the improvements invented by Nash and covered by the 3d, 4th, 5th and 6th claims of the reissue were equally applicable, in the same way and for the same reason and purpose, to the Galloway Patented Engine and the Galloway Kinematic Engine. Even if these forms had not both been known at the date of the patent, they would be equivalent structures to the extent, at least, that *Nash's improvements were equally applicable to both* If this be true, then the 4th and 5th claims must be infringed, for defendants' piston is without journals or bearings and is also made of hard rubber.

It seems equally plain that the piston of defendants' meter controls its own ports in substantially the same way and for the same reason and with the same beneficial results, as the piston of the patented meter. The difference between the two is, there-

fore, merely formal and colorable. Defendants' meter, therefore, infringes the 6th claim.

The same is true of the water passages of the 3d claim in the pistons of defendants' and the patented structure. The object of these passages in both is to coact with the ports in the case to confer upon the piston the function of acting as its own valve, and this they do in substantially the same manner in each.

No rule of law is better settled than that a patentee is protected from the use of all other plans or devices, which, however, seemingly different from the structure of the patent, are the same in principle and operation. There may be many differences between the structure described in the patent and that employed by defendant, but if the claims are not specifically limited to the form described, the question of infringement is not in any way affected by such difference.

Winans v. *Denmead*, 15 How., 338, 341.

In *Cochrane* v. *Deemer*, 94 U. S., 780, 789, the invention consisted of an improved machine for bolting flour. The first claim of reissue 6594 read:

"In combination with the bolt and air space and valves for feeding and delivering without allowing the air to pass therewith, the collecting chambers for simultaneously feeding, separating and delivering the flour, while the light particles carried with the current are deposited and the blast continuously maintained, substantially as set forth."

Justice Bradley, speaking for the Court, said:

"Now, although the defendants use a flat bolter instead of a reel, and use different kinds of valves for feeding and delivering the meal without allowing the air to pass, yet they employ the combinations of devices described in this claim. * * * Though some of the corresponding parts of the machinery, designated in this combination, are not the same in point of form in

the two bolting apparatuses; and, separately considered, could not be regarded as identical or conflicting, yet having the same purpose in the combination, and effecting the same purpose in substantially the same manner, they are equivalents of each other in that regard. The claim of the patent is not confined to any particular form of apparatus, but (in regard to the valves, for example,) embraces generally any and all valves for feeding and delivering the meal without allowing the air to pass through."

Concerning defendants' flat screen, at the bottom of page 786 he says:

"The use of a flat screen instead of a revolving reel for bolting and cleaning the middlings is a mere matter of form. It may be an improved form, and perhaps patentable as an improvement; but it is at most an improvement."

In *Ives* v. *Hamilton*, 92 U. S., 426, 430, the invention related to saw mills and the claim was--

"giving to the saw in its downward movement a rocking or rolling motion, by means of the combination of a cross-head working in the curved guides at the upper end of the saw, the lower end of which is attached to a cross-head, working in straight guides and pivoted to the pitman below the saw, with the crank-pin, substantially as described."

The defendant used a saw in which the guides were not curved, but each consisted of two straight lines which represented two consecutive cords of the curve. The Court said:

"The substitution of guides at the top, made crooked by a broken line instead of a curved line, is too transparent an imitation to need a moment's consideration.

The attaching of the lower end of the saw to the pitman below the cross-head instead of above it, and thereby getting the same movement as before by reversing the motion of the crank, is no change in principle. This is too obvious for discussion.

The combination of the two things in the defendant's mill, namely, the crooked guides above, and the connection of the saw with the pitman below at a point removed from its centre of motion (both being calculated to give to the saw the precise rocking or vibrating motion desired)—is a close copy of the plaintiff's invention; quite as close as is usually made by those who attempt to evade a patent, whilst they seek to use the substance of the invention."

In *Machine Co.* v. *Murphy*, 97 U. S., 120, the invention was for a machine for making paper bags. The patent contained seven claims, but infringement was charged of claim one only, which was:

"Making the cutter which cuts the paper from the roll or piece of the form herein described, that, in cutting off the paper, it also cuts it to the required form to fold into a bag without further cutting out."

The cutter on the machine of the patent was raised by cams, and descended by its own weight vertically upon the table to cut the paper. "Instead of the cutter arranged to ascend and descend, as described in the complainant's specification, the respondents had a knife with a serrated edge," fixed horizontally just below the edge of the table and extending slightly beyond it. This knife did not rise or fall, but there was a striker which made a horizontal blow upon the paper and caused the knife to cut it.

The Circuit Court found no infringement, and dismissed the bill. The Supreme Court reversed the decision, saying:

"Wide differences exist in the arrangement of the devices composing the operative parts of the respondents' machine in question from those exhibited in the machine of the complainant.

Except where form is of the essence of the invention, it has but little weight in the decision of such an issue, the correct rule being that, in determining the question of infringement, the Court or jury, as

the case may be, are not to judge about similarities or differences by the names of things, but are to look at the machines or their several devices or elements in the light of what they do, or what office or function they perform, and how they perform it, and to find that one thing is substantially the same as another, if it performs substantially the same function in substantially the same way to obtain the same results, always bearing in mind that devices in a patented machine are different in the sense of the patent law when they perform different functions or in a different way, or produce a substantially different result.

Now, is it safe to give much heed to the fact that the corresponding device in two machines organized to accomplish the same result is different in shape or form, the one from the other, as it is necessary in every such investigation to look at the mode of operation or the way the device works, and at the result as well as at the means by which the result is attained.

Authorities concur that the substantial equivalent of a thing, in the sense of the patent law, is the same as the thing itself; so that if two devices do the same work in substantially the same way, and accomplish substantially the same result, they are the same, even though they differ in name, form or shape. Curtis on Patents (4th Ed., Sec. 310)."

In *Clough* vs. *Barker*, 106 U. S., 166, 177, the invention was for an attachment to the "bat-wing" burner to regulate the supply of air so as to adopt it to burn air gas or gasoline. Defendants' burners were made in accordance with a patent granted to them subsequent to the date of the patent in suit. The Circuit Court held that the claims were limited by the state of the art, and were not infringed. The Supreme Court reversed the decision and found infringement.

Concerning the differences between complainants' and defendants' structures, the Court, Blatchford, *J.*, said:

"The combination of the first claim of the Clough patent being new, and, consequently,

there never having been any valve arrangement applied to regulate the flow of gas in such a combination, the premises on which the decision of the Court below proceeded fail. Clough is entitled to the benefit of the doctrine of equivalents as applied to the combination of the burner, surrounding tube and regulating tube covered by the second claim of his patent. The regulation in defendants' burners was by a tubular valve on the outside of the perforations instead of on the inside, and performing its work by being screwed up or down, as in Clough's. Although in the Clough structure the burner and surrounding tube revolve together in adjusting their position in reference to that of the tubular valve, so as to let in or turn off the supply of gas through the perforations, and although in the Clough structure the flame revolves by the revolution of the burner, and although in the defendants' burners the revolution of the surrounding tube regulate the supply of gas through such perforations, and neither the burner nor the flame revolve, the defendants' valve arrangement must be held to be an equivalent for that of Clough to the full extent to which that of Clough goes, involving, perhaps, patentable improvements, but still tributary or subject to the patent of Clough. It is true that that patent describes the tubular valve as being inside of the burner tube. But Clough was the first person who applied a valve regulation of any kind to the combination to which he applied it, and the first person who made such combination, and he is entitled, under decisions heretofore made by this Court, to hold as infringements all valve regulations, applied to such a combination, which perform the same office in substantially the same way as, and were known equivalents for, his form of valve regulation."

PART V.

VALIDITY OF REISSUE DISCUSSED.

(*a.*) *Object and effect of reissue.*

(*b.*) *Reissue is valid under Miller* vs. *Brass Co., and cases following it.*

(*c.*) *Reissues applied for after more than two years delay sustained by U. S. Supreme Court since Miller* vs. *Brass Co.*

(*d.*) *3d, 4th, 5th and 6th claims of reissue cover less territory than 1st claim of the original.*

(*e.*) *Addition of elements narrows claim.*

(*f.*) *The reissue effected the same result as a disclaimer.*

(*g.*) *Reissue contains no "new matter."*

THE REISSUE IN SUIT IS VALID, ALTHOUGH APPLIED FOR MORE THAN TWO YEARS AFTER THE DATE OF THE ORIGINAL PATENT, AS THE OBJECT AND EFFECT OF THE REISSUE WAS TO LIMIT THE SCOPE OF THE PATENT AND NOT TO EXPAND IT.

Section 4916 of the R. S. provides that—

"Whenever any patent is inoperative, or invalid, by reason of a defective or insufficient specification, *or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new*, if the error has arisen by inadvertence, accident or mistake, and without any fraudulent or deceptive intention, the Commissioner shall, on the surrender of said patent and the payment of the duty required by law, cause a new patent for the same invention, in accordance with the corrected specification, to be issued to the patentee."

(*a.*) *Object and effect of reissue:*

In this case the specification of the reissue is a word-for-word copy of the original down to the last paragraph, which contains a disclaimer of the subject matter of claim 1 of the original, in the exact words of that claim, in view of the Galloway English patent, to wit:

"I do not claim broadly a piston for water-meters, pumps or motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber, to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, as a motor having a piston of substantially such construction and movement within a cylinder chamber having such construction is shown and described in the English patent of Elijah Galloway, December 14,

1846, No. 11,485; but what I do claim are said elements in combination with additional elements, as hereinafter specified, thereby limiting my claims to the novel features embraced in my meter."

Claims 7 to 13 of the reissue are verbatim copies of claims 2 to 8 of the original, respectively.

Claim 1 of the original was erased, and claims 1 to 6 of the reissue substituted therefor, each of said claims in the reissue containing a word for-word copy of all the first claim of the original with additional limiting elements added thereto.

It is not necessary here to repeat what we have said on the construction of the language of claim 1 of the original. There can be no doubt but that the original first claim covered the structure shown in the Galloway patent and in the book "Kinematics," and that said patent was therefore "inoperative or "invalid * * * by reason of the patentee claim-"ing as his own invention or discovery more than "he had a right to claim as new."

The error in this case arose from ignorance of the existence of the Galloway Patented and Kinematic Engines.

Nash, the inventor, knew of the Galloway Patented Engine on October 19, 1885. Nash, however, had, by assignment dated August 21, 1878, before the issue of the original patent, assigned all his interest therein to the complainant (Complt.'s Exhibit C, Record, p. 85). From the testimony of the president of the corporation complainant it appears that the National Meter Company did not know of the existence of the Galloway patent until September or October, 1886. As soon as he was advised that the first claim of the original patent was invalid because too broad, he immediately took steps to have the patent reissued (Kelley, Q. 21 to 24, Record, p. 31).

Defendants admit that the new claims of the reissue are narrower than the first claim of the original patent, but they contend that they are broader

than the subsequent claims of the original patent and are therefore void. Stripped of all verbiage their position is this: if a man has a patent with a single claim for the combination of A and B, he can at any time reissue and limit his claim to the combination of A, B and C. But if in this patent he has two claims, (1) for the combination of A and B, and (2) for the combination of A, B and C and D, he cannot at any time reissue and claim A, B and C, because, while this would be narrower than his original first claim, it would be broader than his original second claim.

The proposition is ingenious, but is so obviously untenable that a plain statement of it shows its falsity. Clearly, the patent is not broadened by reissue unless the reissue covers something not covered by the original patent. The reissue is narrower than the original if, while not covering anything not covered by the original, it does not cover something that was covered by the original.

(*b.*) *Reissue is valid under Miller* vs. *Brass Co., and cases following it:*

These facts place the present case beyond the criticisms contained in *Miller* v. *Brass Co.*; *Campbell* vs. *James*, *Hahn* v. *Harwood*, and other decisions of the Supreme Court on reissues with expanded claims.

In *Miller* vs. *Brass Co.*, 104 U. S., 350, Justice Bradley says:

"The only mistake in the original patent suggested is, that the *claim was not as broad as it might have been.*

* * * These afterthoughts, developed by the subsequent course of improvement, and intended by an *expansion* of claims, to sweep into one net all the appliances necessary to monoplize a profitable manufacture, are obnoxious to grave animadversions. * * * If a patentee who has no correc-

tion to suggest in his specification except to make his claim *broader and more comprehensive*, uses due diligence in returning to the Patent Office, and says: 'I omitted this,' or 'My solicitor did not understand that,' his application may be entertained, and on a proper showing correction may be made."

"Nothing but a clear mistake or inadvertence, and a speedy application for its correction, is admissible when it is sought merely to *enlarge* the claim."

"The power given by the law to issue a new patent upon the surrender of the original, for the correction of errors and mistakes, has been greatly misunderstood and abused. It was first contained in the act of July 3, 1832, C. 357, and the law was adopted in view of suggestions made in several judgments of this Court. It was carefully confined to cases where the patent was invalid or inoperative by means of a failure to comply with any of the conditions prescribed by the law for giving a clear and exact description of the invention. * * * The act of July 4, 1836, C. 45, enlarged the power to grant reissues by adding an additional ground for reissue, namely, that the patentee had inadvertently claimed in his specification, as his own invention, *more* than he had a right to claim as new. And, with that addition, the law has continued substantially the same to the present time."

After quoting the provisions of the present law, he continues:

"It will be observed that whilst the law authorizes a reissue when the patentee has claimed *too much*, so as to enable him to contract his claim, it does not, in terms, authorize a reissue to *expand* his claim."

After calling attention to Section 3, Act of 1793, Chapter 11, which required the inventor to file a specification of his invention in such terms as would distinguish it from all other things before known, and after calling attention to Section 6 of Act of 1836, which was the first statute requiring the in-

ventor to append to his specification what is technically called a "claim," the learned Judge says:

"It was in the thirteenth section of this Act of 1836 (which first required a claim), that provision was made for a reissue to correct a claim which was too *broad* in the original. Now, in view of the fact that a reissue was authorized for the correction of mistakes in the specification before a formal claim was required to be made, and of the further fact that when such formal claim was required, express power was given to grant a reissue for the purpose of making a claim more *narrow* than it was in the original, without any mention of a reissue for the purpose of making a claim *broader* than it was in the original, it is natural to conclude that the reissue of the patent for the latter purpose was not in the mind of Congress when it passed the laws in question. * * * By a curious misapplication of the law it (reissue) has come to be principally resorted to for the purpose of *enlarging and expanding* patent claims, and the evils which have grown from the practice have assumed large proportions. Patents have been so expanded and idealized, years after their first issue, that hundreds and thousands of mechanics and manufacturers, who had just reason to suppose that the field of action was open, have been obliged to discontinue their employments, or to pay an enormous tax for continuing them.

The granting of a reissue for such a purpose (expanding its claim), after an unreasonable delay, is clearly an abuse of the power to grant reissues, and may be justly declared illegal. * * * Such a process of *expansion* carried on indefinitely, without regard to lapse of time, would operate most unjustly against the public, and is totally unauthorized by 'law.'"

In *Mahn* v. *Harwood*, 112 U. S., 354 (358), Justice Bradley, speaking for the Court, says:

"We deem it proper to say, once for all, that the views announced in *Miller* v. *Brass Co.* on the subject of reissuing patents for the purpose of *expanding and enlarging* the claims, were deliberately expressed and are still adhered to.

Now, in our judgment, a patent for an invention cannot be lawfully reissued for the mere purpose of *enlarging* the claim, unless there has been a clear mistake, inadvertently committed in the wording of the claim, and the application for a reissue is made within a reasonably short period after the original patent was granted. The granting of *such* reissues after the lapse of long periods of time is an abuse of power, and is founded on a total misconception of the law.

Lapse of time may be of small consequence on an application for the reissue of a patent on account of a defective specification or description, or where the original claim is too broad. But there are substantial reasons, *not applicable to these cases,* why a claim cannot be enlarged and made broader after an undue lapse of time. The rights of the public here intervene, which are totally inconsistent with such tardy reissues.

The claim actually operates in law as a disclaimer of what is not claimed; and of all this the law charges the patentee with the fullest notice. Then, what is the situation? The public is notified and informed by the most solemn act on the part of the patentee that his claim to invention is for such and such an element or combination, and for nothing more. Of course, what is not claimed is public property. The presumption is, and such is generally the fact, that what is not claimed was not invented by the patentee, but was known and used before he made his invention. But whether so or not, his own act has made it public property if it was not before. The patent itself, as soon as it is issued, is evidence of this. The public has the undoubted right to use, and it is presumed it does use, what is not specifically claimed in the patent. Every day that passes after the issue of the patent adds to the strength of this right and increases the barrier against subsequent expansion of the claim by reissue under a pretense of inadvertence and mistake. If any such inadvertence or mistake has really occurred it is generally easily discernible by an inspection of the patent itself.

As before stated, *the case is entirely different from that of the reissue,* by reason of a defective specification or description, or *on account of the claim being too broad. In those cases the public in-*

terest is promoted by the change, whilst a reissue for the purpose of making a claim more broad and comprehensive is injurious to the public, since it takes from the public the use of that which it previously enjoyed, and which the original patent acknowledged its right to enjoy. We repeat then, if a patentee has not claimed as much as he is entitled to claim, he is bound to discover the defect in reasonable time, or he loses all right to a reissue.

"The truth is, as was shown in *Miller* v. *The Brass Co.*, that this class of cases, namely, *reissues for the purpose of enlarging and expanding* the claim of a patent, was not comprised within the liberal terms of the law which created the power to reissue patents."

The case of *Eames* v. *Andrews*, 122 U. S., 40, 59, decided May, 1887, is commonly known as the Driven Well Case. The patent on which suit was brought was reissued more than three years after the date of the original patent, and was sustained. The Supreme Court, speaking through Mr. Justice Matthews, said:

"If the amended specification does not enlarge the scope of the patent by extending the claim so as to cover more than was embraced in the original, and thus cause the patent to include an invention not within the original, the rights of the public are not thereby narrowed, and the case is within the remedy intended by the statute. *Those cases in which this Court has held reissues to be invalid were of a different character*, and were cases where, by the reissued patent, the scope of the original was so enlarged as to cover and claim as a new invention that which was either not in the original specification as a part of the invention described, or, if described, was, by not being claimed, virtually abandoned and dedicated to public use."

Reissues broadening the scope of the monopoly secured by the original patents after a delay of more than two years, have been declared invalid by the Supreme Court for two reasons:

(1.) Because the power to reissue patents to broaden claims was not comprised within the

terms of the law which created the power to reissue patents.

(2.) Because a claim to a given monopoly operates in law as a formal disclaimer to all that which is not included within the limits of that monopoly.

Neither of these reasons apply to reissues to narrow claims, because—

(1.) The power to reissue patents to narrow claims is comprised within the literal terms of the law which created the power to reissue patents.

(2.) There is in the original patent no disclaimer of an exclusive monopoly covered by the claims of the reissued patent, but, on the other hand, the public has notice in the original patent that the patentee claims all that is covered in the reissued patent and more.

Therefore the Supreme Court has gone out of its way to announce that "if the amended specification "does not enlarge the scope of the patent by extend- "ing the claims so as to cover more than was em- "braced in the original, the rights of the public are "not thereby narrowed, and the case is within the "remedy intended by the statute."

And again: "The case is entirely different from "that of a reissue by reason of a defective specifica- "tion or description, or on account of the claim being "too broad. In these cases, the public interest is "promoted by the change."

(c.) *Reissues applied for after more than two years delay sustained by the United States Supreme Court since Miller* v. *Brass Co.*

Cases have been decided by judges of the Supreme Court since the decision in *Miller* v. *Brass Co.*, sustaining patents which have been reissued more than two years after the date of the original patent. In one of these the patent was reissued

after a delay of more than three years; in another, the patent was reissued after a delay of more than five years; and in the other, the patent was reissued after a delay of more than ten years. The language of the Court in Topliff *vs.* Topliff, 145 U. S., 156, is also in point.

The first case referred to is *Yale Lock Co.* v. *Sargent*, 117 U. S., 536, decided in April, 1886. In this case the application for reissue, which had five claims, was filed more than five years after the date of the original patent, which had but three claims. The first claim of the original patent was in the following words:

"The rotating tumbler I, when separated and isolated in action from the permutation-wheels, and so arranged that any inward pressure upon the bolt will be exerted on the bearing of said tumbler, and have no action or effect upon the said permutation-wheels, substantially as and for the purpose herein specified."

The first claim of the reissue which was held to be good and to be infringed, was as follows:

"In a combination lock for safe and vault doors, a bolt I, which turns on a pivot or bearing, when said bolt I is used in a lock having an ordinary sliding lock-bolt, and in connection with the separate bolt-work of the door, and so arranged so as to receive the pressure of the said bolt-work without transmitting it to the wheels, or other equivalent works of the lock."

The Court held that the reissue claim was, if anything, narrower than the original, being restricted by the use of the words "used in a lock having no ordinary sliding lock-bolt." The words "or other equivalent works of the lock," the Court, speaking through Judge Blatchford, said had no expanding force, being merely the statement of a legal proposition.

Claim 4 of the reissue was held to be bad as an unlawful expansion.

The next case was *Eames* v. *Andrews* (*supra*), decided in May, 1887. The patent was reissued more than three years after the date of the original patent and the reissued patent was sustained.

In the case of *Reed* v. *Chase*, 25 Fed. Rep , 94, decided August 14, 1885, the patent was for an improvement in harrows. The original patent contained one claim. After a delay of nearly ten years the application for reissue was filed and had seven claims. At the original hearing of the cause the reissue was held valid. The litigation spread to other circuits and doubts were expressed by the judges in those circuits whether the ruling in favor of the validity of the reissued patent could be sustained in view of the decisions of the Supreme Court on the subject. Upon these facts a petition for rehearing was allowed, and the case was reheard by Mr. Justice Matthews, sitting at Circuit, the validity of the reissue being the only question discussed. After a "full, thorough and able argument upon the question, as though it were an original one," the validity of the reissue patent was affirmed. The Court said:

"No facts in excuse of these apparent laches are shown or claimed to exist, and upon the well-established doctrine of the Supreme Court it must be assumed, without anything further, that the reissued patent, so far, at least as it covers anything not within the claim of the original is void. This is conceded by counsel for the complainant. On the other hand, it is maintained that if the claims of the reissued patent, or one or some of them, are either within the scope of the original patent or are legally identical with it, to that extent the reissued patent can and ought to be upheld. This is the doctrine of the Supreme Court as declared in *Gage* vs. *Herring*, 107 U. S., 640, and is conceded to be so by the counsel for the defendant."

After construing the claims, the Court says :

"Upon this construction it cannot be successfully contended that any of the seven claims contained in the reissued patent, nor all of them combined, embrace anything not covered by the original. The claims of the reissued patent are separately within the original, and all combined are no more than its legal equivalent."

In *Cochrane* vs. *Deener*, 94 U. S., 780, the original patent, which contained three claims, was, after a delay of more than eleven years, reissued in two divisions, containing four claims, and the Court held that the claims of the reissues were all narrower than the claims of the original, and were all infringed.

(*d.*) *3d, 4th, 5th and 6th claims of reissue cover less territory than 1st claim of the original.*

In the case at bar there can be no question whatever but that the 3d, 4th, 5th and 6th claims of the reissue are each narrower than the first claim of the original, and that all combined they are less than its legal equivalent. No structure which did not infringe the original 1st claim can possibly infringe either of the reissued claims.

It is, therefore, evident that neither separately nor all of said claims combined cover as much territory as the original first claim. But a structure such as the Galloway Patented Engine or the Galloway Kinematic Engine, &c., would infringe the original first claim, and does not infringe, nor, being prior in date, does not anticipate either of the reissued claims. Therefore, the patent has been narrowed by reissue.

An illustration may make this clearer. Suppose we have a patent claiming broadly the State of New York. Subsequently it is ascertained that a certain

county in the State, say New York County, is already occupied. Our patent is too broad, as it includes that to which we have no right. We then disclaim ownership to the County of New York, but claim the counties of Kings, Queens, Westchester, Dutchess, Orange, &c., separately by name. The number of our claims has been increased, but the territory of each of the new claims is included in, and is less than the territory covered by the original claim; and the territory covered by all of the new claims combined is less than that covered by the single original claim, because they cover nothing outside of the State of New York, and they do not cover New York County, which is within that State.

Therefore, a reissued patent may have a larger number of claims and yet cover less territory; that is, be narrower than the original patent. The number of claims in a patent is no indication of the extent of the territory covered.

(*e.*) *Addition of elements narrows claim.*

A claim for a combination of elements can only be narrowed by adding elements to the combination. The proposition is an elementary one.

For the converse of the proposition, see *Miller* v. *Brass Co.; Campbell* v. *James; Mahn* v. *Harwood* and numerous other recent decisions of the Supreme Court invalidating reissues in which the claims have been broadened by omitting elements.

(*f.*) *The reissue effected the same result as a disclaimer.*

The patent in suit is in legal effect the exact equivalent of the original Nash patent with a disclaimer added thereto. Neither the specifications nor the drawings are changed and there is no alteration made in the claims except to limit them by the addi-

tion of new elements. This is also the office of a disclaimer.

In *Cartridge Co.* v. *Cartridge Works*, 112 U. S., 624, Blatchford, *J.*, delivering the opinion of the Court, says (p. 642):

"A disclaimer can be made only when something has been claimed of which the patentee was not the original or first inventor, and when it is intended to limit a claim in respect to the thing so not originally or first invented." * * * "*It is true that this same end may be reached by a reissue, when the patentee has claimed as his own invention more than he had a right to claim as new.*"

In the case of a disclaimer it has been repeatedly held that it need not be filed until the invalidity of the claim has been judicially determined by the Court of last resort.

O'Reilly v. *Moore*, 15 How., 62, 121.
Seymour v. *McCormick*, 19 How., 96, 106.
Silsbee v. *Foote*, 20 How., 378, 387.
Yale Lock Co. v. *Sargent*, 117 U. S., 536, 554.
Gage v. *Herring*, 107 U. S., 640, 646.

The same rule applies where the reissue has no other object or effect than to narrow the claims.

Matthews v. *Flower*, *supra*.

In the present case the application for reissue was made as soon as the owners of the patent were advised that in opinion of counsel the claim was too broad. The reissue for such purpose would have been within reasonable time even after suit brought and decision rendered.

(*g.*) *No "new matter" has been inserted in the specification by reissue.*

4916 R. S., referring to applications for reissue, provides:

"The specification and claim in every such case shall be subject to revision and *restriction* in the same manner as original applications are, * * * but no *new matter* shall be introduced into the specification."

We have seen that the only way in which a claim for a combination can be restricted is by the addition of a new element. A restricted claim is in one sense a claim for a different invention, and the restricting element added, or even a disclaimer is, in one sense, "new matter."

But this is obviously not the sense in which these words are used in the statute, otherwise it would be impossible to reissue a patent and restrict its claims. Such a construction would in effect abrogate the right conferred in literal terms upon patentees by Section 4916.

Further than this, such a construction would be in direct conflict with that portion of the same section which confers upon the patentee the right to revise and restrict his claims during the pendency of a reissue application, in the same manner as in an original application.

The "new matter" which will invalidate a reissue is new *substantive* matter.

As was said by this Court in *Powder Co.* vs. *Powder Works*, 98 U. S., 126, 137 and 138:

"The specification may be amended so as to make it more clear and distinct; the claim may be modified so as to make it more conformable to the exact rights of the patentee, but the invention must be the same. This prohibition is general, relating to all patents; and by 'new matter' we suppose to be meant *new substantive matter*, such as would have the effect of changing the invention or of introducing what might be the subject of another application for a patent. The danger to be provided

against was the temptation to amend a patent so as to cover improvements which might have come into use or might have been invented by others after its issue."

This is quoted with approval in the recent case of *Topliff* vs. *Topliff*, 145 U. S., 156–166.

In the case at bar it is to be observed that if defendants infringe either of the claims of the Nash reissue they must of necessity have infringed the first claim of his original patent. The patent was not reissued to cover defendants' meter, because that was already covered by the Nash original patent. It was reissued because it also covered the Galloway engines and was too broad.

It is plain that a reissued patent having the same specification and drawings, which does not cover anything not covered by the original patent, cannot be for a "different invention." An examination of the reported cases on this point will show that every case in which a reissue has been held void as being for a "different invention," or as containing "new matter," the claims of the reissued patent covered some structure not covered by the claims of the origina patent.

In conclusion, it submitted that the decree of the Circuit Court should be reversed.

EDMUND WETMORE.
J. EDGAR BULL.

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SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, A. D. 1892.

No. 192.

THE NATIONAL WATER METER COMPANY,

APPELLANT,

v.

THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS,

APPELLEE.

BRIEF FOR APPELLEE.

FREDERICK H. BETTS,
GEORGE L. ROBERTS,
FREDERICK P. FISH,
Of Counsel for Appellee.

SYNOPSIS OF BRIEF.

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Supreme Court of the United States.

OCTOBER TERM, 1892.

No. 1[illegible]2.

THE NATIONAL WATER METER COMPANY, *Appellants*,

v.

THE BOARD OF WATER COMMISSIONERS OF THE CITY OF YONKERS, *Appellees*.

BRIEF FOR THE APPELLEES.

This suit is brought for the alleged infringement of reissued Letters Patent No. 10,806, granted to the appellant as assignee of Lewis H. Nash, February 8, 1887, for an improvement in rotary water meters. The original Letters Patent, of which the patent in suit is a reissue, were numbered 211,582, dated January 21, 1879. The reissued patent was therefore granted over eight years after the grant of the original, and the application for the reissue was filed nearly eight years after the date of the original patent. Although the original patent is entitled for an "Improvement in Rotary Water Meters," and the reissue is entitled for a "Rotary Water Meter," both the original and reissue state that "it is also contemplated to use the machine as a motor [engine] or as a pump." The invention, therefore, is not limited to water meters, but is, and is stated to be, for engines, pumps or meters. It appears clearly from the record that the relations between meters and steam engines are so close that any engine, reciprocating or rotary, may be used as a water meter.

See Renwick, p. 178, Int. 6; Tilden, p. 216, Int. 15; Brevoort, p. 15, Int. 5.

As Mr. Renwick states, p. 178, Int. 6, "Long prior to the invention of Mr. Nash, it was well known that steam and water engines, whether rotary or reciprocating, could be used as meters or to meas-

ure the flow of the fluids which passed through them; and various forms of rotary steam engines and of reciprocating engines had been used as meters." When Mr. Renwick resigned his position as principal examiner in the Patent Office in 1852, he left there "a manuscript index that I had made of more than two hundred rotary engines not patented in this country" (p. 194, Cross-Int. 19). The number of such engines since that date has been very large.

The meter used by these appellees, a specimen of which is introduced in evidence, and marked "Exhibit D," has to some extent the general construction and mode of operation that characterize so-called rotary steam engines, pumps and motors, and to that extent only as we contend it resembles the apparatus of the complainant's reissue.

The defences set up in the answer and relied upon by these appellees are, *first*, that the reissue is invalid as to the four claims relied upon by the appellant, because it was applied for and secured eight years after the grant of the original patent, not for the purpose contemplated by the statute, of correcting any error that arose from inadvertence, accident or mistake, but for the purpose of changing the patent so that it would claim combinations of devices which were not the subject of the claims of the original Letters Patent or described as being the inventions of said Nash for which he applied for and obtained said original Letters Patent; in order that by means of the reissue the appellant might prevent the Hersey Meter Company (who manufactured the meters used by these appellees, and who has assumed the defence of this suit) from carrying on its business; and further upon the ground that the said Nash and the appellant "unreasonably and fraudulently delayed undertaking to correct said alleged defects [if there were any] by reissue," and did not make application for said reissued Letters Patent until said Hersey Meter Company had made and sold large numbers of water meters of the type here before the court, and that the reissue was applied for and obtained "for the sole purpose of procuring new Letters Patent for other and different inventions from those forming the subject matter of the claims of said original Letters Patent." (Ans., p. 10.)

The answer further avers that said reissued Letters Patent were procured by deceiving the Patent Office and by fraudulent and untrue representations to the Patent Office, and that any right to reissue "was forfeited by its [the appellant's] delay and laches in not so doing until long after it had full knowledge of all the facts upon which said application for a reissue purported to be based, and until long after said Hersey Meter Company had made, sold and introduced into use water meters identical with the said Hersey meters used by this appellee." (Ans., p. 10.)

The *second* defence is, that the said Nash did not, in compliance with the statute, "particularly point out and distinctly claim the part, improvement or combination which he claimed as his invention or discovery," but that, on the contrary, "he wilfully and fraudulently made his claims in said original and said reissued Letters Patent in ambiguous language intending to mislead the public, with the view of making it difficult to determine the real scope of his said claims and of reserving the right to contend for such interpretation thereof as the exigencies of any particular case, might, in his judgment or that of his assignee, require." (Ans., p. 10.)

The *third* defence is, that the Hersey meter used by these appellees does not infringe the Nash reissue. The appellees contend that their meter is substantially different in construction and mode of operation from the meter of the appellant's reissue, and that no invention is shown or described in that reissue upon which is, or could have been, based any claim which would be infringed by the Hersey meter. (Ans., pp. 8 and 9.)

The Meter of the Nash Patent.

A thorough understanding of the structure and mode of operation of the meter of the Nash patent is essential to a discussion of the defences upon which the appellees rely. The specification of the reissue, except for the insertion of a disclaimer, is the same as that of the original patent, and the four claims of the Nash reissue upon which the appellant relies purport to be based upon the first claim of the Nash original patent.

It is clear that the Nash invention is very narrow. His entire

structure except a few details of comparatively trifling importance were found in the Galloway structures hereinafter referred to.

There is no substantial controversy in this case as to the construction and mode of operation of the appellees' meter, or those of the Nash patent. The questions at issue, in so far as the relations of the apparatus are concerned, are chiefly to be answered from the patent itself, when construed in connection with the apparatus it describes, and on this point there is controversy.

The attention of the Court is particularly called to Mr. Renwick's deposition, which contains a full but concise statement of the position upon which the appellees rely, and which cannot be discussed to so good advantage in this brief.

The general principles upon which the meter of the appellant's patent is constructed and operated are the same as those characterizing all displacement water meters. A solid body moves through an enclosed space, displacing in its movement a certain amount of water which is properly fed into and discharged from the space in which the solid body moves. All that is necessary, in order to measure the water that passes through this or any other meter of this character, is to determine how much water is displaced during one complete movement of the solid body in its case. If a piston meter is employed, the amount of water displaced in one movement of the piston will be measured by the space through which the piston passes in its progress from one end of the enclosing cylinder to the other. In the case of a rotary meter like that of appellant's patent, the amount of water displaced by one revolution of the piston in its case will be the basis for calculating the gross amount passed through the meter in any given time. In all such meters, the moving body or piston is connected with some registering mechanism which records the number of times that the solid piston has moved through the enclosing space; that is to say, the number of times it has reciprocated in an ordinary piston meter, or has revolved in a rotary meter like those here before the court. Assuming that in one reciprocation of a reciprocating piston meter, or in one revolution of a rotary piston meter, a cubic foot of water is displaced, the registering mechanism will move one step, indicating that one cubic foot has passed. The reading of the registering mechanism

at the end of a certain definite period will therefore indicate the number of reciprocations or revolutions that have taken place, and consequently the number of cubic feet of water that have passed through the meter during that period.

According to the patent, and, in fact, the entire novelty of the meter of the appellant's patent lies in the peculiar shape and relation of the piston and case, and the peculiar movement of the piston in making one revolution within the case, and in the peculiar porting of the structure, which enables the water to enter and discharge from the meter in the proper manner to insure the proper motion of the piston in its case, and the uniform displacement of a given amount of water at every revolution of the piston. The appellant's patent shows several forms of meters, differing in detail, but all described as mere modifications of one type, and all, in fact, operating in the same way and on the same general plan. The substantial elements of this structure, even were old.

The first claim of the original Nash patent points out specifically the character and relation of the piston and case, the special movement of the piston within the case, and the nature of the division of the chamber into receiving and discharging spaces, constituting the fundamental invention which Mr. Nash undertook to patent. That claim is as follows: —

"A piston for water meters, pumps and motors, having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an *eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber, to effect its division at two or more points on its sides into receiving and discharging spaces*, c c, *which communicate with the inlet and outlet*.'

The italics, which are ours, indicate features of novelty which are essential to the structure claimed, and are inherent in its operation.

The various modifications of the Nash type of meter shown and described in his patent are illustrated by appellant's Exhibit E (p. 21, record), and that form which is most fully described, namely, the one shown in Fig. 3 and Fig. 12, and which is the form most

nearly resembling the commercial or Crown meter made under the Nash patent, is illustrated fully and clearly by appellees' Exhibit Skeleton Model Nash Meter, which shows the case, the piston and the porting of the Nash patent (Figs. 3 and 12) with entire accuracy. Renwick, p. 179, Int. 6.

In the meters of the Nash patent there are projections, both on the piston and on the enclosing case in which the piston revolves. As the patent states, the piston must be enough smaller than the case to enable it to rotate in the case, and it must have at least one less projection than has the case. The water enters at the bottom through a hole in the bottom plate of the case, upon which plate rests the piston of the meter. This opening is shown in Fig. 1 of the drawings of the Nash reissue, where it is marked "J." A similar outlet passage is in the centre of the top plate of the case. In the meter piston, shown clearly in perspective and in section in Figs. 4 and 5 of the patent, are a series of inlet and outlet water passages,—one inlet and one outlet passage for each chamber or recess between the projections of the piston. One inlet passage leads into the side-wall of each chamber or recess between the projections of the piston from a hole in a circle of holes at the bottom of the piston; and one outlet passage leads from each of said chambers or recesses to a hole of a circle of holes at the top of the piston. In Fig. 12, where there are six of these chambers, there would be six inlet and six outlet passages through the piston, each inlet and each outlet passage being independent of all the others.

An examination of appellees' Exhibit Skeleton Model will show that in any given position of the piston in its case, some but not all of the inlet holes in the bottom of the piston are over and therefore open to the single inlet hole in the bottom plate of the case, and that some but not all of the outlet holes in the top of the piston are under and therefore open to the single outlet hole in the top plate of the case. Each orifice in the bottom of the piston is free to receive water when opposite the orifice in the lower plate, and when not opposite that orifice it is closed so that it cannot receive water. In the same way each outlet orifice is free to discharge water when

it is open to the outlet orifice in the top plate, and when not opposite that orifice it is closed so that no water can be discharged through it. As the piston moves about in its case, the inlet and outlet holes at the bottom and top of the piston respectively are opened one after the other to the inlet and outlet orifices in the plates. The inflowing water, which passes up through the orifice in the bottom plate of the case, may enter any inlet passage in the piston which is open to it, and will pass through any such inlet passage to the recess or chamber between some two projections on the piston to which such inlet passage leads. In like manner the outflowing or discharging water may pass out of the meter up through any outlet passage in the piston which is open to the single orifice in the top plate; and when any outlet passage is so open, water will be discharged through it from the chamber between projections on the piston from which it leads. The openings of the inlet passages at the bottom of the piston are called in the patent "inlet ports," and the openings of the outlet passages at the top of the piston, "outlet ports."

The claims and the specification require that the piston should move so as to effect the division of the case "at two or more points on its sides into receiving and discharging spaces *c c* [shown in Fig. 12] which communicate with the inlet and outlet." These receiving and discharging spaces are separated by the piston, which is always in such a position in the case that there is "a direct contact of the piston and cylinder at two or more dividing points within the continually changing cylinder spaces" (Rec. p. 323), whereby the space between the piston and case from which water is discharging is entirely separated from the corresponding space into which water is entering.

In Fig. 12, the bearing points, which separate the discharging from the receiving spaces when the piston is as there shown, are formed at the terminals of the line *b*, by the bearing of the projection on the piston and case at *b b'* and the bearing of the projection on the piston with the inner wall of the recess of the cylinder at the other end of the line *b*. The space *c* at the right of the line *b* is

open to the inflowing water; that is to say, all the inlet passages in the side walls of the chambers or recesses of the piston that are at the right of the line *b* are open to the inflowing water when the piston is in the position shown in that figure; while in that position of the piston all the outlet passages in the side walls of the chambers or recesses of the piston that are at the left of the line *b* are open for the discharge of the water. On the contrary, when the piston is in the position shown in that figure, the outlet passages from the chambers on the right of the line *b*, are closed, and the inlet passages from the cavities of the piston at the left of the line *b* are closed. The water, therefore, is coming into the spaces on the right of the line *b* under pressure. The pressure of this incoming water is at right angles to the line *b*, and moves the piston in Fig. 12 towards the left, thereby rotating it upon its axis in a direction opposite to that of the hands of a watch. This motion is clearly shown by revolving the piston in appellees' Exhibit Skeleton Model. The water at the left of the line *b* in Fig. 12 passes out through the discharge orifice while water is flowing in at the right of the line *b*.

The line dividing the receiving from the discharging space of Fig. 12 is a constantly changing line, because the piston is constantly moving, and with each motion it brings new points on the periphery into contact with new points on the case, thus forming new discharging and receiving chambers separated by the piston on a line drawn through the new bearing points established by the motion of the piston. As the piston moves, one inlet passage after another is opened to the inlet orifice in the lower plate of the case, and one outlet passage after another is opened to the outlet orifice in the top plate of the case. These changing lines of division are defined by the specification and claims as being upon "continually changing lines across the centre of said chamber." There is no stability to the receiving and discharging spaces, each of which is continually changing in contour and in position in the case as the piston moves.

From an inspection of the drawings Fig. 12, and an examination of the movement of the piston in appellees' Exhibit Skeleton Model, the movement of the piston "upon continually changing lines across

the centre of said chamber," which effects the division of the cylinder "at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet," and the fact that these receiving and discharging spaces are continually changing in position relative to each other and to any point on the piston and case, will clearly appear. Each point on the piston travels clear around the case, and new receiving chambers and new discharging chambers are constantly established by new contacts of the piston and cylinder on lines across the centre of the case. As the receiving and discharging chambers change with the constantly changing lines of division across the centre of the case, each inlet port at the bottom of the piston is closed when the chamber to which it leads forms part of the discharging space, and each outlet port is closed when the chamber from which it leads forms part of the receiving space. Each inlet port is opened when the chamber with which it is connected forms part of the receiving space, and each outlet port is opened when the chamber with which it is connected forms part of the discharging space. In some forms of the Nash meter, there may be chambers formed by the piston and case which are for the time being neither receiving nor discharging chambers. (Renwick, p. 180, Int. 6.) These "neutral chambers," so called, do not affect the operation of the meter, and need not be further considered in this connection.

The movement of the piston of the Nash meter is a "compound" movement which carries each point on the periphery of the piston step by step clear around the case. The motions of the piston are described as "side-rocking" and "rotary." The two are inseparable. By so much as the piston "side-rocks" it "rotates," and its rotation is made up entirely of the series of "side-rockings." In each complete movement of the piston about the case, a certain amount of water is received into and discharged from the meter in the manner above described, and in each revolution the registering mechanism is moved one step. The amount of the water that passes through the meter during one revolution of the piston being determined, all that is necessary in order to determine how much water has passed through the meter in a given time, is to

multiply that amount by the number of times that a complete revolution has taken place as indicated by the registering mechanism.

The first claim of the original Nash patent specifies as essential to his structure the following characteristics: The piston must have alternate bearing points or projections and recesses. The cylinder chamber must likewise have alternate bearing points or projections and recesses. The cylinder chamber must be so related to the piston that the latter is "adapted to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber." By this construction and movement, the division of the chamber "at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the outlet and inlet," is effected. "The eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber," which characterizes the meter of the Nash patent and is an essential element of his claim, is only possible because of the special relation of the alternate bearing points or projections and recesses of the piston and of the cylinder, which are also essential elements of the claim, and by means of which the piston is "adapted" to have this movement. Again, the only possible way shown or suggested in the Nash patent in which the division of the chamber "at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet" (which mode of division is also essential to the claim) can be effected is by means of the "eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber," caused by the relative shapes of the piston and case, as pointed out in the claim above quoted. These vital characteristics of the Nash invention are so related that they must be treated together.

It is clear from the statement in the patent that the side-rocking or eccentric motion of the piston is "the rocking of the piston from one bearing point to another across the chamber of the cylinder." (Rec., p. 323.) That is to say, in all forms of the Nash meter shown in the patent there is a constant side-rocking of the piston from one bearing point to the next, whereby bearings are established

between the piston and cylinder on new lines, which lines separate the receiving from the discharging spaces. These "side-rockings" make up the "rotary" movement of the piston.

Taking the form illustrated in Fig. 3 of the patent and by appellees' Exhibit Skeleton Model, if the piston there shown is placed in a given position in its cylinder and is then moved in one direction or the other, it clearly rocks sidewise in the direction towards which it is moved, on a bearing that is on one side of the piston, and which is in substance the centre about which the opposite side of the piston rocks for a certain space. This pivotal point on which the piston rocks bodily is continually changed as the bearing point between the piston and the cylinder and the lines dividing the receiving from the discharging spaces change, but the entire movement of the piston is made up of a succession of such side-rockings.

In the similar form of piston illustrated in Fig. 12 of the patent, the operation is the same in this particular. One point on the periphery of the piston is substantially stationary, while the opposite point rocks sidewise on it for a certain distance. Immediately new bearings are established, another point on the periphery becomes stationary, and the opposite point rocks sidewise for a certain distance, and so on during the whole revolution of the piston.

So in the forms of piston illustrated in Fig. 9, Fig. 10 and Fig. 11 of the patent, as the piston moves from one bearing point to another "across the chamber of the cylinder" to make new lines of separation between the receiving and discharging spaces, there is the same distinct and continuous side-rocking action about the chamber of the cylinder from one bearing point of the piston to another. All these pistons are illustrated in appellant's Exhibit E, and also in a model which will be produced by the appellees at the hearing, which differs from appellant's exhibit only in that handles are placed upon the pistons. By watching these handles, the side-rocking movements of the various pistons in and about their cases will be distinctly seen. All these side-rockings are, as specified in the claim, "within and upon continually changing lines across the centre of said chamber"; that is, as shown on a diagram opposite

p. 179 of the ~~appellees~~' record, where one side-rocking of the piston there shown is from the point a to the point a'. The dotted lines indicate the change in the line "across the centre of the chamber" accompanying the "side-rocking" there illustrated. The next side-rocking of the piston would be upon new lines, and so on continuously. These continually changing lines across the centre of the cylinder upon which the piston side-rocks are also the lines of division between the receiving and discharging chambers.

Renwick (p. 179), referring particularly to appellees' Exhibit Skeleton Model, says: "Now I have had a handle attached to the axis of the piston of this skeleton model. It will be seen by turning this handle that the piston rotates on its own axis, and that, in doing this, the points of the piston and the handle rock over from side to side as the handle revolves. This is the side-rocking motion set forth in the patent, and may be easily traced by moving the piston around slowly."

If the piston of the Nash meter had merely a single side-rocking movement, the meter would be incapable of measuring water without substantial reorganization, because it could only rock back and forth for a short distance and on a single bearing point. It, however, continuously rocks "from one bearing point to another across the chamber of the cylinder," and always in the direction of the flow. This motion involves a *rotation about its own centre*, so that pistons in all forms of the Nash meter have what he calls in his patent a "compound motion," namely, a motion of rotation about the centre of the piston, made up of the series of "side-rocking" motions above described.

Mr. Renwick, in his answer to Int. 6, p. 178, of the record, clearly shows that the compound motion of the Nash piston is absolutely essential to the operation of his meters, and is a necessary part of the first claim of his original patent and the four claims of the reissue which the appellees are alleged to infringe. The patent itself is equally clear upon this subject. It states, at the bottom of p. 1, column 1, that "as the piston rocks from one bear-

(record p. 94)

ing point to another directly across the centre of the cylinder, it is at the *same time revolved* to effect the measurement of the water passing into and from the cylinder spaces." Mr. Renwick makes refer nce to other parts of the patent bearing on this point on pp. 178, 179 of the record.

It is distinctly stated in the patent (Rec., p. 325), that "the compound motion of the piston and contacting dividing points are *due* to the fact that the piston has one or more less points of projection than the cylinder." This construction characterizes all forms of meters shown in the Nash patent, and no form of meter can be conceived in which the "eccentric or side-rocking" motion of that patent can be obtained unless there are one or more less points of projection on the piston than on the cylinder.

The eccentric or side-rocking movement of the piston being an essential element of the claim of the Nash meter, this feature of construction upon which such movement depends, namely, the presence of at least one less projection on the piston than on the case, is to an equal degree an element essential to any meter that embodies the Nash invention. It is because Nash recognized this fact, that the patent itself states with emphasis that "the compound motion of the piston and the contacting dividing points are *due* to the fact that the piston has one or more less points of projection than the cylinder." Rec., p. 325. See Renwick, p. 178, Int. 6. Again, for the purpose of emphasizing still further the vital importance of the rotation of the piston as well as its side-rocking action, the patent says that "the space within the cylinder must be of such form and sufficiently larger than the piston to allow it to have this compound motion." Rec., p. 325.

The whole purpose of this peculiar motion of the piston in the cylinder of the Nash patent is, as stated in the claim, to effect the division of the cylinder "at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet." These "points" are at the terminals of the line which in any given position of the piston separates the receiving and

discharging spaces of the meter, and are points on the periphery of the cylinder.

The patent states, Rec., p. 323 : —

"The piston operates with two or more continually changing points or lines of bearing or contact with two or more points of contact bearings of the cylinder at different points at the same time."

Again, Rec., p. 323 : —

"The continually changing points or lines of bearing of the piston and cylinder are formed by alternate projections and recesses, and the eccentric or side-rocking movement of the piston is governed by the extent of the projecting bearing-points and the depth of the recesses, so that in the rotation of the piston around its own centre, one or more projecting bearing points of the piston will pass into corresponding recesses at one point of the cylinder and in contact with and over one or more projecting bearing points of the cylinder at a different point, thereby always maintaining a direct contact of the piston and cylinder at two or more dividing points within the continually changing cylinder spaces."

Again, Rec., p. 323 : —

"The object of these continually changing points or lines of contact at different parts of the piston and the cylinder, and of the continually changing volumes of the receiving and discharging spaces formed thereby, is to allow the water to flow through a valve into and from these spaces as they fill and discharge without impeding its flow or lessening its force."

Again, Rec., p. 325 : —

"The object of this compound motion is to form bearing points or lines of contact of the piston with the cylinder walls, on opposite sides thereof, at the same time, as shown in Figs. 3 and 12, whereby to divide the cylinder into receiving and discharging spaces. Of whatever form these alternate recesses and projections, they must be such that while they are in contact upon one side of the cylinder, they must also, at the same time, have a contact at the opposite or a different side of said cylinder, and in this way divide the cylinder into spaces."

These divisions into receiving and discharging spaces, which are defined as being necessarily such that while the projections and recesses of the cylinder and piston "are in contact upon one side of the cylinder, they must also at the same time have a contact at the

opposite or a different side of said cylinder," are clearly shown in the drawings of the Nash patent.

In Fig. 9, receiving space *c* is on one side of the piston, and the discharging space *c* is on the opposite side of the piston, and the line which divides the receiving from the discharging chamber is across the body of the chamber, or as the patent says, across the centre of the chamber. In Fig. 10, again, the division of the chamber into receiving and discharging spaces is on a line across the chamber between the contact points shown, the receiving space *c* being at the left of the line, and the discharging space *c* being at the right of the line, the piston rocking in the same direction. In Fig. 11, also, the division of the chamber into receiving and discharging spaces is on a line across the body of the chamber, and between the contact points, the receiving space *c* being upon one side of the line and the discharging space *c* being upon the other side of the line. In like manner, in Fig. 12, the line of division is across the centre of the chamber, the receiving space *c* being at the right of the piston, and the discharging space *c* at the left of the said line. In every form of meter illustrated in the Nash patent, the division into receiving and discharging spaces is "*across the centre of said chamber*," and in no case are receiving and discharging spaces formed merely by dividing a recess of the cylinder or of the piston.

We submit that it is an essential element of the Nash invention that the line dividing the cylinder into receiving and discharging spaces should be across the case from one point on the periphery of the case to a substantially opposite point, and that no meter would be an infringement of the Nash patent in which the discharging and receiving spaces were not formed upon such lines of division.

The porting of the Nash meter is adapted only for a division into receiving and discharging chambers across the centre of the cylinder. The function of the porting is to regulate the flow of the water into and out of the spaces formed by the cylinder and piston in such manner as to allow the inlet water to flow only into the receiving spaces and the water in the cylinder to escape only from the discharging spaces. The admission of any of the inlet water into the discharging

spaces of the cylinder and the discharging of any water from the receiving spaces of the cylinder, would alike be fatal to the operation of the meter. Instead of this porting in the body of the piston, a separate valve may be so arranged and connected with the meter (as shown in Figs. 7 and 8 of the drawings) as to produce the same result, it being only necessary that the motion of this separate valve should be controlled by the peculiar compound movement of the piston so as to let the inflowing water into the receiving spaces only, and to permit the outflow of water from the discharging spaces only.

We submit that the Nash patent clearly recognizes the fact that his invention relates to a meter having the characteristics specifically pointed out in the first claim of his original patent. That is to say, his patent requires (1) that any meter to be within it must have a piston performing the side-rocking or eccentric motion above described from one bearing point to another across the centre of the cylinder, and the consequent motion of rotation about its own centre which is involved in this side-rocking and is necessary to make this side-rocking possible; (2) that as a consequence of this motion, the piston of the Nash meter must divide the chamber on continually changing lines across the chamber, running from one point on the case to another and opposite point into receiving and discharging spaces between which are said division lines; (3) that the motion of rotation about its own centre which characterizes the piston of each of the structures described and shown in the patent must invariably attend the side-rocking movement, and the division of the chamber into receiving and discharging spaces above referred to, whereby the measurement of the water is effected; (4) that this compound motion, made up of the motion of rotation and the side-rocking motion which characterizes the piston of the Nash meter, must result from a structure having at least one less projection on the piston than on the cylinder, and a piston enough smaller than the case to enable any point on the periphery of the piston to pass clear around the case.

The appellees contend that all these limitations are embraced in the first claim of the Nash original patent as features essential to his

invention stated in the broadest terms. They contend that no other conclusion is consistent with the specific requirements of the patent and furthermore, that no claim could possibly be drawn on the Nash structure which would not bring in some and probably all of these essential requirements. Any meter to be within the first claim of the Nash original patent must have "a piston having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber, to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet." It must therefore necessarily involve the compound motion of the Nash piston, and consequently there must be one more projection on the cylinder case than on the piston. The piston must side-rock; that is to say, it must rock from one bearing point to another across the case during the progress of its compound motion. By its motion the chamber must be divided into receiving and discharging spaces by the formation of "bearing points or lines of contact of the piston with the cylinder walls on opposite sides thereof at the same time." Record, p. 325.

As will be readily pointed out, in all the particulars which we believe to be essential to this first claim, the appellees' meter differs from those of the Nash patent.

It seems clear that the words "eccentric or side-rocking," which appear in the Nash original specification and the first claim are used synonymously, and that they refer to the particular motion which characterizes all the pistons of the Nash meters, and which alone is described or suggested in the Nash patent. Mr. Renwick says, on p. 179–180, folio 25, "Now, whatever may be the meaning of the words 'eccentric motion' as loosely used in conversation, it is certain that in this patent it means the side-rocking motion which I have attempted to describe." Mr. Brevoort, in his deposition in support of the *prima facie* case (p. 21, Cross-Ints. 8–20), undertakes to distinguish between the terms "side-rocking" and "eccentric," his

distinction being that the term "side-rocking" was used as descriptive of those forms of the Nash meter in which "if a point on the piston be selected, it will be found that the point forms small arcs in the movement of the piston." And he says that the pistons shown in Figs. 3, 9 and 12 of the reissue are "side-rocking," while those shown in Figs. 10 and 11 are not "side-rocking" within the meaning of the reissue, but are "eccentric." This distinction is essential to the appellant's case, because as Mr. Brevoort himself testifies (p. 24, Cross-Int. 25), the piston of the appellees' meter has no side-rocking movement whatever, as he defines the term, but only an eccentric movement.

The patent itself shows that Mr. Brevoort's distinction is without foundation. Mr. Renwick states the real fact as follows (p. 182, Int. 7):—

"He [Mr. Brevoort] is not only wrong in fact, but he contradicts the reissue. The terms 'eccentric or side-rocking action' are, as I have before said, used throughout the reissue as synonyms. Eccentric action means side-rocking, and side-rocking means eccentric action; and the reissue, as if for the express purpose of leaving no doubt upon the matter, uses the words 'side-rocking' only with reference to the very Figures 10 and 11 which Mr. Brevoort says do not side-rock. I quote from p. 2 of the reissue, commencing at line 56: 'Figs. 9, 10 and 11 are modified forms of the cylinder bearing points or lines, and the corresponding forms of *side-rocking* and rotary pistons adapted for co-operation therewith.' The italics are mine. The pistons of these figures do side-rock, that is, their acting points describe figures resembling an epicycloid."

The language quoted by Mr. Renwick appears also in the original Nash patent. Whatever might be the meaning of "side-rocking" and "eccentric" apart from the connection in which they are used in the Nash reissue, it is clear that as used in that reissue they mean one and the same thing — and that is the peculiar side-rocking movement which characterizes the pistons of all the Nash meters in the patent.

A consequence of this peculiar compound side-rocking and rotary movement of the pistons of Nash meters is, as pointed out by Mr. Renwick (p. 179, Int. 6), that

"each point of the piston revolves all around the axis of the piston, each point passing in succession over all the points of the cylinder, and each point drawing when in motion precisely the same curve." "Each one of the points traces precisely the same single curve, and that curve is very near the curve called in geometry an epicycloid, that is, the curve drawn by any point in the tire of a wheel when the wheel is revolving with its tire resting and travelling upon a cylindrical surface, the variation from an epicycloid being due to the fact that the piston is like a cog wheel working upon a circular rack."

The epicycloidal curves made by the projection on the piston of Fig. 12 of the Nash patent are shown in diagram opposite p. 179 of the record.

A further characteristic of the structures of the Nash patent is that (to quote from the specification of the reissue, Rec., p. 324),

"the valve opens some and closes others of the ports in succession in such a manner as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the eccentric or side-rocking and rotary movements of the piston, and thereby avoid any undue lateral pressure of the water upon the piston."

Mr. Renwick (p. 189) explains exactly what is meant by this. Referring to the diagram opposite p. 179 of record, he says:—

"This direction is correct, because the tightness of the Nash meter, and therefore its accuracy in measuring, is due to the relative shape and size of the piston and cylinder, and not to the effect of the water pressing the contacting points of the piston against the cylinder."

Another characteristic of the Nash meter, depending upon the fact that the pressure of the water on the entering side causes the piston to revolve and has no other effect, is that the water "does not tend to keep the piston tight when it wears, or to keep two of its points in contact with the cylinder. When the points either of the piston or the cylinder wear in this contrivance, the meter will leak and measure incorrectly. . . . In this meter the tightness is secured solely by the size and fit of the parts, piston and cylinder, and not by the pressure of the water." (Renwick, p. 180, Int. 6.)

Another characteristic of the Nash structures which depends upon his special porting and mode of operation, is that the direction of motion of the piston may be reversed, that is, in the words of the patent, "In the use of the meter, the inlet may become the outlet, and *vice versa*." (Rec., p. 327.) (See Tilden, p. 216, Int. 14.)

The pistons of the Nash meters are altogether unbalanced; that is, the action of both the inflowing and outflowing water tends to push the body of the piston up against the top of the case, so that its friction with the top of the case would tend to retard its motion. (See Brevoort, pp. 57, 58, Cross-Ints. 103–110.)

A modification suggested in the Nash patent is that instead of having the valves in the body and ports of the piston, an outside valve may be employed, such as illustrated in Figs. 7, 8, 8*a* and 8*b*. This valve has its inlet divided by a partition, and "the water enters through the top of the valve by the ports *h*, and passes out through a side port *g* in said valve into corresponding ports *i* in the valve seat, thence through the passages *j j* into the filling spaces *e* of the cylinder, and from the discharging spaces it passes through the passages *j' j'*, and the ports *i'* in the valve seat, through the port *g'*, and escapes through the bottom of the valve into the discharge pipe." The patent says that this outside valve may be used in any of the forms of the meters shown in the patent, but that "the number of inlet and outlet ports of the valve seat" must "correspond to the number of the bearing projections of the cylinder."

The clauses in the specification in which the two forms of valve are described are only material in this case as showing that the patentee, beyond any question whatever, regarded the essence of his invention as residing in the peculiarly constructed and related piston and cylinder, having the peculiar operation pointed out in his first claim and explained above.

He says, Rec., pp. 323, 324: —

"In this connection, and for effecting this operation [the proper inlet and outlet of the water] the valve may be formed with and constitute a part of the piston; or it may be separate therefrom and controlled by a connection therewith."

"The valve is arranged so that the cylinder spaces on one side of the piston as it revolves have free inlet for the water through one set of the valve ports, while the spaces on the other side of the piston have free outlets for the water through the other ports of the valve, causing the piston to move with the flow. In this operation, the valve opens some and closes others of the ports in succession in such a manner as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the eccentric or side-rocking and rotary movements of the piston, and thereby avoid any undue lateral pressure of the water upon the piston. This result is accomplished in a more satisfactory manner by increasing the number of the bearing points or lines of the cylinder and piston, as shown in Fig. 3. When the valve is arranged within the piston, it is formed by inlet and outlet openings or ports in the ends of the piston, communicating by means of passages in or through the piston with the spaces of the cylinder. These end openings or ports communicate with corresponding openings or ports in the ends of the cylinder, which form the inlet and outlet ports thereof.

"In the arrangement of the valve separate from the piston, the latter has no inlet and outlet ports; but these are formed within a case communicating with the cylinder, and operate in the same manner with respect to the constantly changing cylinder spaces, and the action of such separate valve is the same as one formed within the piston, and its motion is controlled by any suitable free attachment with said piston.

"The results of these different arrangements of valves are identical, and any suitable form of valve may be used that will operate with a periodic relation to the movements of the piston, so as to give a uniform flow and a uniform pressure upon the working parts."

Again, he says (Rec., p. 326):—

"The function of the valve is to regulate the flow of the water in and out of the spaces of the cylinder in such manner as to produce the compound rotation and cross movement of the piston; and this function can be made operative whether the valve be arranged within the piston, as described, or separate from and connected with it, as shown in Figs. 7 and 8 of the drawings, it being only necessary that the motion of the valve should be controlled by the compound motion of the piston in any arrangement; and I do not wish to confine myself to either of the specific arrangements of the valve shown, or to any specific construction of such valves in relation to the piston, so long as the valve and the piston co-operate to produce the results stated."

Again (Rec., p. 327):—

"An important feature of my invention embraces the combination,

with a piston adapted to operate substantially as described, of a valve controlled thereby, irrespective of its specific construction or arrangement."

The only other alternative constructions suggested in the patent are equally limited to devices which co-operate with the peculiar structure of the first claim. The patentee suggests (Rec., p. 327) a preference for making the piston of hard rubber, but says "it may be of any suitable material." Again he says (Rec., p. 327), that he has described and prefers in practice "that the piston shall have the compound motion described; but it is obvious that the piston may be fixed and the cylinder be made to have the relative compound motion. So in like manner, both the cylinder and the piston may have a separate conjoint motion yet retaining the same relation to each other." Thus in dealing with the question fundamentally involved in this case, he suggests alternative constructions all of which involve to an equal degree the relation of parts and mode of operation which we contend characterize his invention.

A further feature of construction pointed out in the specification, must be considered because it has been made by the appellant in the reissue here in suit the basis of a claim which we contend has no foundation whatever in the specification of the original patent.

As is pointed out by Mr. Renwick (p. 177, Int. 6; p. 183, Int. 9), in view of the fact that the centre of the piston in the Nash meters (with the possible exception of those shown in Figs. 10 and 11) traverses, in the revolution of the piston, not in a circle but in an irregular path in the nature of a series of epicycloidal curves, it is obvious that if the shaft of the piston which drives the registering mechanism were rigidly connected to the crank by means of which the shaft of the registering mechanism is driven, no revolution of the piston would be possible, because the only possible path for the shaft of the piston is in a series of epicycloidal curves, while if rigidly attached to the crank of the registering mechanism it would be forced to move about in a circle. For this purpose and no other there is a loose connection between the crank of the registering mechanism and the shaft of the piston. That is to say, the shaft of

the piston merely bears against the crank, and is not rigidly attached to it. It is therefore able to conform itself to the irregular path which it must take during the "compound motion of the piston."

The patent states (Rec., p. 323), "to *accommodate this eccentric or side-rocking motion of the piston*, it must have a free or shifting connection with the crank or mover of the registering mechanism"; and again (Rec., p. 327), "it will be seen that the connection of the piston with the registering mechanism is such as to allow of a free or shifting action *to accommodate the side-rocking movements* of the piston across the centre of the cylinder chamber and maintain a driving relation with the dial mechanism." These statements are perfectly accurate with reference to the meters of the Nash patent.

The claims of the reissue upon which the appellant relies purport to be based upon the first claim of the original, which has already been discussed. Some of the other claims of the original must be briefly considered, because the appellee contends that the claims of the reissue upon which suit is brought are not in fact as the appellant contends, limitations of the first claim of the original patent, but are rather attempts to expand other claims of the original which the appellee could never have been charged with infringing.

The *second claim* of the original is for the piston and cylinder chamber, with their recesses and projections, the latter so arranged as to "intermatch with each other at one or more bearing points at one side of the cylinder, and allow the projections of each part to bear upon and to pass each other at two or more points at a different side of the chamber." This claim differs from the first only in that it is more specific and looks at the structure from a somewhat different point of view.

The *third claim* of the original patent is for a piston having the side-rocking and revolving movements "combined with a registering mechanism by means of a free or shifting connection," to accommodate the side-rocking movements of the piston across the centre of the cylinder chamber and maintain a driving relation with the dial mechanism. This is for the peculiar mode of connecting the piston and registering mechanism, made necessary by the fact that the pis-

ton side-rocks; and this claim covers all the "freedom of motion" that characterizes the piston of the Nash meter, and is limited to the combination with a side-rocking piston, which makes such freedom of motion necessary.

The *fourth claim* is for the rotary and side-rocking piston dividing the cylinder at two or more bearing points on its sides, combined with a valve controlled by the movement of said piston and adapted to open and close receiving and discharging ports in succession to effect the purpose stated. This claim is for the peculiar piston of the Nash structure when properly controlling its valve.

The *fifth claim* is for the same piston when contructed with the inlet and outlet ports, and water passages in the piston itself, as shown, combined with a proper case.

The *sixth claim* is for substantially the same mechanism as the fifth, that is, for the above described piston and cylinder, the former having in it water passages whereby the pressure of the water is brought at "right angles to the direction of the side-rocking and rotary movements of the said valve piston."

The *seventh* and *eighth claims* are for immaterial details which need not be considered.

The Appellees' Meter.

The differences between the appellant's reissue and the original patent upon which it is based, and the reason why those changes were introduced by reissue, can be more readily understood after a consideration of the structure and mode of operation of the appellees meter. An examination of that meter and of the circumstances under which the appellant's reissue was taken, will, we believe, throw light upon the action of the appellants in taking their reissue, and disclose the purpose for which it was taken.

The appellees' meter, represented in this case by appellant's Exhibit D, is manufactured by the Hersey Meter Company, of Boston, Mass. It was designed by Mr. James A. Tilden, whose deposition appears in this case in the record, pp. 212–218, and was patented by him in Letters Patent of the United States, No. 324,503 (reissue, No. 10,778) and No. 357,159 bound in at the end

of the record. (Tilden, p. 213, Int. 5.) He completed his first meter in November, 1884, and the meter was introduced into the market in the fall of 1885. Prior to December, 1886, when the reissue in suit was applied for, about three hundred and eighty Hersey meters had been sold. (Tilden, p. 214, Int. 7.) It had also been extensively advertised prior to that time. (Tilden, p. 215, Int. 12.)

Mr. Tilden, who had had a large experience with water meters (p. 213, Int. 2), devised the Hersey meter, as he testifies,

"to overcome certain defects which were popularly believed to exist in rotary meters then in the market. I refer particularly to the liability to stoppage from small particles of foreign matter ordinarily carried along by the water; also it was to design a meter which will be self-compensating for wear. The pistons of rotary water meters made up to that time would wear rapidly, especially in waters containing a destructive sediment, and there was no provision for taking up this wear. The piston of the Hersey meter is so designed, with reference to its cylinder, that it is self-compensating and will wear tight." (Tilden, p. 213, Int. 6.)

The Hersey meter has proved itself to be very successful. (Tilden, pp. 214, Ints. 8, 9, 10, tests on p. 220.)

The Hersey meter, like that of appellant's patent, and like many other so-called rotary meters, engines and pumps, has a piston moving in a case and displacing in each complete movement of the piston a known amount of water. As in the case of the Nash and other meters, each complete movement of the piston in its cylinder is registered, and by a simple process of multiplication the registering mechanism indicates the number of cubic feet of water that have passed through the meter. As in the case of all rotary meters, pumps or motors, the Hersey meter has proper inlet and discharge ports whereby the water is introduced into the meter at the proper time to insure its successful operation. The appellees contend that the resemblance between the Tilden or Hersey meter and the meter of the Nash patent is confined to these general characteristics which are common to these two and a large number of similar structures, and that in all substantial particulars the appellees' and the appellant's meters are absolutely unlike in construction and mode of operation.

In the Hersey meter, the piston never side-rocks and never rotates, as does that of the Nash patent. Unlike the Nash piston, the Hersey piston has a number of projections *equal* to the number of projections on the case, and is of such shape and so large as compared with the space inside of the cylinder, that no projection on the piston can ever pass out of the depression in the cylinder into which it is placed at the start. The entire movement of the piston is a sliding movement, during which each projection on the piston continually points in exactly the same direction, and is continually retained in a certain given chamber of the cylinder. There is no division of the case into receiving and discharging spaces on lines across the centre of the case, such as characterizes the Nash meter: and under no conditions of use are there any bearings between the piston and cylinder at opposite points in the case, for the purpose of forming such spaces or for any other purpose. The discharging and receiving spaces in the Hersey meter are formed in each and every cavity of the cylinder, and no receiving or discharging space ever embraces more than a certain portion of one particular cylinder cavity. In the Nash meter, several cavities in the case unite to make up one and the same receiving or discharging space.

An examination of the Hersey meter, Exhibit D, will show clearly its operation.

The ports, or inlet and outlet passages for water in the Hersey meter, are in the end plates of the cylinder, and not at all in the piston itself, as in the Nash meter. The inlet ports are the large holes, six in number, and one for each recess in the cylinder, which extend through the bottom plate each near one side of its recess. There are outlet ports both in the top and bottom plates. The only orifices in the top plate are outlet ports, and the smaller holes in the bottom plate are also outlet ports. The outlet ports in the two plates are exact duplicates of each other. Those in the top plate are directly over those in the under plate, and water is always passing out in an equal degree from the outlet ports in the top and bottom plates of any given chamber of the cylinder which is discharging. These outlet ports do not extend through the plate, but are simply slots or passages cut into the plate and connecting the two adjacent holes in the plate, as seen in Exhibit D.

The piston is always in contact with the walls of the cylinder on one side thereof, and where it is so in contact with the cylinder, a projection of the piston is dividing a cavity in the case into two compartments which are made water tight by the bearings and relation of the projections of the piston and case adjacent to the compartment under consideration. The compartments are respectively inlet and discharge spaces, one of them filling from the inlet port in the bottom plate and the other discharging from the outlet ports in the bottom and top plates. Two, or at most three, of the adjacent cavities may be in operation at the same time. All the inlet ports are on the side of the cavity from which the projection of the piston moves, and all the outlet ports are on the other side of the cavity towards which the piston moves. The water entering under pressure into the water tight compartment formed in the chamber of the cylinder between a projection on the piston and the adjacent projection on the case, moves the piston toward the outlet port, and during this motion the water in the compartment of the cavity on the other side of the projection and in which is the outlet port, passes out through that hole in the outlet port which is nearest to the outside periphery of the cylinder. When this hole, into which the water directly passes, is open, and the passage with which it is connected is also open to the large central cavity seen in the piston, the water passes out of the outlet orifice in the top and bottom plates of the compartment and is delivered at once into the central cavity in the piston, from which it is discharged by a proper opening up through the meter. This operation goes on simultaneously in two or three adjacent cavities of the case, in each of which the inlet water fills the constantly expanding inlet space, and the outlet water leaves the constantly contracting outlet space, while the pressure of the inflowing water causes the projections on the piston to slide from one side of the cavity to the other, always maintaining its close bearing against the case so as to keep the two compartments of the cavity water tight.

The same operation is repeated in each of the chambers in succession, the water entering on one side of a projection of the piston and passing out on the other side of that projection in each and all

of the cavities. The chambers of the cylinder which are at any time not divided by the projections of the piston into receiving and discharging spaces, are full of water, but are not measuring water, because although the inlet passages to them are open, the outlet passages are not in a position to be open to the central cavity of the piston. In the Hersey meter, this inflowing water in the chambers that are not measuring is utilized "to keep the piston in contact with the walls of the cylinder. Otherwise the piston will not perform its duty in displacing water." (Tilden, p. 216, Int. 13.) The piston being perfectly loose in its case requires that this should be done; for if it were not constantly held against the side of the case, the water would simply flow around in and through it, there would be no definite displacement, and the water would not be measured. To obviate this difficulty, Mr. Tilden introduced into his porting an additional characteristic, which is of vital importance to the operation of the Hersey meter, but is not present in the Nash meter, where it would have no function. That is to say, while two, or at the most three, of the six cavities of the cylinder are measuring water at any given time, the remainder of the cylinder chambers and the spaces between the piston and the case where the water is not being measured are always open to the water flowing in under pressure, but the outlets from these spaces in which no water is being measured are kept out of communication with the central cavity of the piston. The pressure of the water introduced into the portion of the meter in which water is not being measured at any time forces the piston up against the opposite side of the case and into close contact with the walls of those cavities of the cylinder in which water is being measured, and holds it there firmly. This inflowing water which presses the piston up against the case, but is not at the time being measured, affords the very "lateral pressure" which Mr. Nash says must be avoided in the meters of his patent. Without this lateral pressure, the appellees' meter would be entirely inoperative.

A full description of the appellees' meter is found in the deposition of Mr. Renwick, and the construction of the porting is clearly described in the deposition of Mr. Tilden (p. 215, Int. 13).

As Mr. Renwick points out in his answer to Int. 15, page 186, each and every point on the appellees' meter from the centre to the periphery traverses a complete and perfect circle as the piston moves about the case, each circle being eccentric to all the others, and all being of the same size. In the Nash meters, as already pointed out, the projections of all the meters and the centres of all but two travel in paths made up of epicycloidal curves, and the path of each projection is clear around the centre of the meter.

The piston of the Hersey meter controls the inlet and outlet ports in the heads of the case. It controls the outlet ports by passing over them. The inlet ports, which are in substance always open in order to get the lateral pressure required to hold the piston up against the sides of the case, need never be covered by the face of the piston, as the walls of the piston afford in every case a complete barrier between the discharging and receiving spaces at the time when such a barrier is required. As the Hersey meter is constructed, however, the lower face of each projection of the piston substantially though not quite covers for a moment its particular inlet port during each of its movements in its chamber.

The piston of the Hersey meter is made of hard rubber, which Mr. Nash says in his patent he *prefers*. Unlike the Nash piston, it has no passages whatever through it except the central cavity, which is really part of the discharge pipe through which all the water from the outlet passages in the top and bottom plates passes. The meter would be effective and practically operative if there were no such cavity extending through the centre of the piston. There is really needed only a shallow depression in the top of the piston to receive the water as it passes through the passages in the top plate. In that case, however, only half as much water could be discharged through outlet holes of any given size because the outlet holes at the bottom of the plate would not be able to deliver their water into the discharge pipe.

Moreover, if the discharge were at the top only, and the inlet at the bottom only, the piston would not be so well "balanced." That is to say, it would have a greater tendency to bear hard upon the top

plate than is the case when the relief is at both the top and bottom of the cylinder. (See Brevoort, p. 69.) As we have already pointed out, an absolute want of balance of the piston is one of the characteristics of the Nash porting, while by duplicating the outlet passages such a balance of the Hersey piston is secured.

The piston of the Hersey meter, like that of the Nash patent, is not rigidly attached to the crank which drives the registering mechanism. Inasmuch, however, as the shaft at the centre of the Hersey piston traverses an exact circle, that meter would be equally operative even if the shaft were attached rigidly to the crank, while in the Nash structure, the reason of the loose connection between the piston and registering mechanism is that the centre of the piston travels in an epicycloid and not in a circle, and therefore, could not get around at all if rigidly connected with the crank.

The loose connection between the piston and crank in the Hersey meter is merely for the purpose of allowing the piston to draw back a short distance from the side of the case where it is doing its work, if such action is necessary to permit the passage of a pebble, a nail, or any other small solid body that may be carried along by the water. If such small substances are in the water, they will move out the Hersey piston from the side of the case for a moment and pass through the meter. The lateral pressure of the water in those chambers which are not measuring water will immediately force the piston back to its work after the foreign substance has passed. Inasmuch as the Nash piston fits its case tightly, no foreign solid body whatever can pass, and if it attempts to pass, the probabilities are that it will be jammed between the piston and case and prevent the meter from further operation.

A further characteristic of the Hersey meter is that it will wear to a fit; while if the Nash piston wears, it will allow the water to leak around between the piston and case. (Renwick, p. 190, Int. 15.)

The Disclaimer in the Nash Reissue.

As already stated, the specification of the Nash reissue is the same as that of the original patent, except that at the end of the original

specification is interpolated in the reissue the following disclaimer: —

"I do not claim, broadly, a piston for water meters, pumps and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces, *c c*, which communicate with the inlet and outlet, as a motor having a piston of substantially such construction and movement within a cylinder chamber having such construction is shown and described in the English patent of Elijah Galloway, December 14, 1846, No. 11,485; but what I do claim are said elements in combination with additional elements, as hereinafter specified, thereby limiting my claims to the novel features embraced in my meter."

The contrivance of the Galloway patent thus disclaimed is the same, in so far as the character and relation of the piston and case, the movement of the piston, and the action of the inflowing and outflowing fluid are concerned as the appellees' meter, and resembles the device of the Nash reissue only in that the Galloway structure has a series of projections on its rotary piston and a series of projections on the cylindrical case within which that piston moves. The motion of the Galloway piston is altogether different from that of the pistons of the Nash reissue. The mode of dividing the chamber into receiving and discharging spaces is altogether different from anything shown in the Nash reissue. The porting being adapted to this other movement and other mode of division is of course entirely different from anything in the Nash reissue, and is closely analogous to that of appellees' meter.

A specimen of the Galloway engine is here before the court marked "Exhibit Galloway Engine." In this engine, there is not, as in the Nash reissue, a greater number of projections on the cylinder than on the piston, but on the other hand, there is the same number. Moreover, in the Galloway engine there is no rotary motion whatever of the piston, as is the case with the Nash meters, but on the other hand, there is as in appellees' meter merely a sliding motion of the whole piston in its case. While in the Nash meters

each projection on the piston visits one chamber after another of the cylinder, passing clear around the cylinder in one revolution, in the Galloway structure each projection remains constantly in the same chamber of the cylinder. While in the Nash meters the divisions into receiving and discharging spaces are divisions across the case, caused by bearings between the piston and cylinder on opposite sides of the case, in the Galloway structure, as in the Hersey, they are merely divisions of each chamber of the case, caused by the bearing of one projection of the piston against the chamber in the cylinder. While in the Nash meters the piston is closely confined in its case in such manner that no motion of it is possible except a motion at right angles to the direction of the flow of the water which carries it around, in the Galloway structure, as in the Hersey, the piston is loose in its case, and moves bodily within it following closely the periphery of the case, but with the side opposite that which is bearing against the periphery of the case at a substantial distance from the other side of the periphery of the case. But the Galloway piston, like the Hersey and unlike the Nash, is not small enough, and is not so shaped as to be able to rotate about its centre.

The Nash patent states in terms that side pressure of the water is to be avoided, and that the whole flow of the water is to be devoted to giving to the piston the side-rocking movement in the case. In the Galloway structure, on the other hand, as in the Hersey, the pressure of the water not only moves the piston about in a path absolutely different from that in which the Nash piston travels, but also devotes itself in part to keeping the piston up against the side of the case, or in other words exerts upon the piston the very "side pressure" which the Nash structure is intended to avoid. Finally, in all the structures of the Nash reissue, there is the side-rocking (involving rotary) movement of the piston above described, from one bearing point to another of the case, while the Galloway piston, like the Hersey, has no side-rocking movement whatever, but a sliding movement of the whole body of the piston, each projection always pointing to the same point of the compass and remaining in the same chamber of the case in all stages of its movement. As an incident to this distinction between the movements of the Galloway and Nash

structures, we find that in the Nash structure the projections of all his pistons move in a path made up of a series of epicycloidal curves, all of which surround the centre of the case; while in only two, those of Figs. 10 and 11, do their axial points form circles. On the other hand in the Galloway structure as in the Hersey, any and all points upon the piston move in paths which are exact circles, no two of which circles are concentric, and all of which are of the same size. If a handle be placed upon a Galloway or Hersey piston, like the handle on appellees' Exhibit Skeleton Model of Nash Meter, and the piston be moved in its case, that handle will move exactly like the rod connecting two driving wheels of a locomotive. It will always point in the same direction, and will swing forward and back in parallel lines. It will have none of the side-rocking motions that are clearly seen when the piston of the skeleton model is moved, and it will not move in constantly changing lines across the centre of the chamber as does the handle of appellees' Exhibit Skeleton Model.

Mr. Renwick states with reference to the disclaimer (p. 178, Int. 6), that the engine of the Galloway patent "operates in a totally different way from that of the reissue," and in various parts of his deposition points out the substantial differences above referred to. He says of the disclaimer (p. 186, int. 12):—

"In my opinion, the disclaimer has no force or effect at all in altering or changing the description of the meter in the specification, or the meter which is referred to in the claims. The disclaimer was entirely unnecessary, as the description and claims of the original patent neither described nor claimed the thing which is disclaimed or a thing having the mode of operation of that which is disclaimed."

And he proceeds (p. 186):—

"It is perfectly evident, without alluding to other distinctions, *first*, that the piston and the cylinder have the same number of points, and therefore cannot have the side-rocking action described in the patent as arising from an unequal number of points; *second*, that the piston does not revolve on its own axis; *third*, that the points of the piston do not describe epicycloids; *fourth*, that each projection of the piston always acts in the same depression of the cylinder, and does not travel throughout all the depressions in the cylinder in succession, as in the Nash meter; *fifth*, that one point of the piston cannot by any possibility stand on one projection of the cylinder, as

illustrated in Fig. 12 of the Nash patent, a position which is essential to the operation of the Nash meter. It is also evident that the water acts in a different way in the thing disclaimed from what it does in the Nash meter, and that the Nash meter will become leaky by wear, while the thing disclaimed will tend to grind itself tight, and be as tight after some wear as it was originally."

It is now clear why the appellants went out of their way to disclaim a structure substantially different from that shown and specifically described in the Nash patent, and which we submit was not within the scope of any of his claims. The appellees' meter alleged to be an infringement of the appellant's patent was introduced into the market and extensively advertised and sold some time before the reissue of the Nash patent. As already shown the appellees' or Hersey meter, represented by Exhibit D in this case, has the precise piston and case of the Galloway patent, and precisely the mode of operation of that patent. That is to say, it has the same number of projections upon the piston and case instead of having a different number as in the Nash reissue. Its receiving and discharging chambers are made by a division of the several recesses of the cylinder independently, and not by division of the whole cylinder itself, as in the Nash reissue. The projections of the appellees' piston, as is the case with the Galloway, describe small circles, none of which are concentric, and do not describe epicycloids, as is the case with the Nash meter. All points of the appellees' piston describe small circles like the Galloway, a peculiarity not found in the Nash meters. The appellees' piston, like the Galloway, slides bodily about the case, each projection on the piston remaining constantly in its own chamber of the case, while each projection of the piston in the Nash meter visits successively all the chambers in the cylinder.

The appellees' piston, like the Galloway, does not rotate or side-rock, as do the pistons of the Nash patent, and the appellees' meter, like the Galloway, requires side pressure to keep its piston up against the side of the case, which side pressure is by the terms of the Nash re-issue to be avoided in his structures. The appellants recognized that if the first claim of their original patent could be so

construed as to cover the appellees' meter, it would be met by Galloway. They apparently believed that if they were to disclaim the Galloway structure they would thereby enlarge their own patent by the new and false suggestion that the Galloway structure and movement were within the patent as originally drawn, and thereby be in a position to ask the Court to construe the claims that they sought to obtain by reissue in such a way as to cover the Galloway or Hersey structure as well as the structures which alone form the basis of the original Nash patent, when combined with certain additional elements. In this attempt, they were aided by the fact that it is not easy to understand the peculiar structure and mode of operation of the Nash meter, and that the language used in describing that meter, both in the specification and claims, is so involved and peculiar that unless an unusually careful examination were given to the matter, the Patent Office might readily be deceived as to the scope of the original patent and the character of the Nash inventions.

The testimony of Mr. Kelley, the appellant's president, is clear to the point that at the time of the reissue the appellees' meter was specially considered and the reissue taken for the purpose of bringing that meter within the scope of the Nash patent. (Kelley, pp. 32–33, Cross-Ints. 28 to 32.) The appellants hoped that their pretended disclaimer would bring within the range of the Nash patent such structures as the Galloway engine and the appellees' meter, as equivalents of the Nash structure, although they were clearly not such equivalents, and not within the scope of that patent before. We desire also to call attention at this point to the fact, which will be referred to again later, that in securing the reissue, Mr. Nash made oath that the Galloway engine was unknown to him until a month prior to December 14, 1886, that is to say, that he did not know of it up to November 14, 1886. He now swears, when another patent of his which clearly refers to Galloway and which was applied for in October, 1885, is shown him, that he knew of Galloway as early as October 19, 1885, thirteen months prior to the date sworn to by him in the Patent Office. (See Nash, Rec., pp. 210, 211, Ints. 1–5.)

Having deceived the Office so far as to be allowed to disclaim the Galloway structure as being the same in substance as that pointed out in their first claim, it was then easy for them, under cover of views as to the reissue law prevailing in the Patent Office which have since been declared by the Supreme Court to be unsound, to secure claims which, on their face purport to be limitations of the first claim of the original patent, the limiting elements being features of construction found (as the appellants contend) in the appellees' meter, which was well known to them, and not (as the appellants profess to believe) found in the Galloway. Accordingly, having reproduced the original Nash specification and added the disclaimer which broadens that specification so far as to bring within its scope the Galloway, and consequently the Hersey structures, they expand the original first claim of the Nash patent into six new claims, each of which in terms is for the subject matter of that original first claim plus certain additional elements which the appellants found in the Hersey meter. In reality, however, if the disclaimer can have the force which the appellants would give to it, each of these six new claims is for the original subject matter of the first claim of the Nash original patent, enlarged by the addition of the structure of the Galloway patent, with the new elements added. It is four of these six new claims, the third, fourth, fifth, and sixth, that the appellees are alleged to infringe.

The Claims of the Nash Reissue upon which the Appellant Relies.

Mr. Renwick's analysis of the four claims of the Nash reissue upon which the appellant relies is so full and clear that no better statement can be made of the scope and effect of those claims. No attempt is made by the appellant to controvert his views except in certain immaterial details. The appellant places its chief reliance upon the proposition that Mr. Renwick is wrong in denying that the Galloway and Hersey structures are each substantially different from that of the Nash meter, and argues that the fundamental characteristics of all three devices are substantially the same. This proposition will be considered later.

Each of the four claims of the Nash reissue upon which the appellant relies embodies all the elements of the first claim of his original patent already fully discussed (*supra*, pp. 5–22), related and operating as therein described. That is, they all relate primarily to "a piston for water meters, pumps, and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet." This language occurs in all of the claims upon which the appellant relies.

We contend that the above quoted passage from the claims involves necessarily a structure in which the piston "side-rocks" from one bearing point on the case to another; that this "side-rocking" must result in a division of the case, into receiving and discharging spaces, which spaces are not contained in any one chamber of the case, but are separated on lines extending across the case from one point of its periphery to another, which lines of division are "the continually changing lines across the centre of said chamber" upon which the piston side-rocks; and that the porting involved is necessarily the porting required for this special arrangement of receiving and discharging spaces and this peculiar side-rocking piston.

It is further required by the patent (Rec., p. 325) that "of whatever form these alternate recesses and projections, they must be such that while they are in contact upon one side of the cylinder they must also, at the same time, have a contact at the opposite or a different side of the cylinder and in this way divide the cylinder into spaces." The previous sentence of the specification says that "to form bearing points or lines of contact of the piston with the cylinder walls on opposite sides thereof at the same time, as shown in Figs. 3 and 12, whereby to divide the cylinder" into such spaces, is the object of the compound motion.

Moreover, the operation of the structure required by the terms of all the claims must be such that the piston shall *rotate about its centre*, because of the series of "side-rockings," every point on the periphery of the piston visiting in turn every projection and depression in the case. This is the "compound motion" of the patent, and, in the words of the patent itself, is "*due* to the fact that the piston has one or more less points of projection than the cylinder." Again, in the words of the patent, to get this compound motion, "the space within the cylinder *must be* of such form and sufficiently larger than the piston to allow it to have this compound motion"; in other words, to allow it to revolve about its centre as well as to side-rock. This compound motion is in the patent itself stated to be essential to the operation of the meter. (See Renwick, p. 183, Int. 9.)

Mr. Renwick proceeds (p. 184): —

"The *third* claim is to the combination of a piston with a cylinder, being the piston and cylinder having unequal numbers of points, as I have before described, so combined together that the piston shall have an eccentric or side-rocking motion within and upon continually changing lines, so as to effect the division of the chamber into receiving and discharging spaces; and by reference to the patent, especially at Fig. 12, it will be seen that the space within the cylinder is divided diametrically, and that the whole of one side of this contrivance is substantially, I do not mean to say exactly, a receiving chamber, and the other side a discharging; that the receiving and discharging chambers are on opposite sides of the same diametrical line.

"Now, this is not the whole of the claim, but the piston must be in addition provided with internal water passages. These passages are the twelve passages, six for the entrance of water and six for the discharge of water, which I have before described. The claim is not limited to the precise number of each set of these passages, because in Fig. 11 there would be only four of these passages, two in each set, but in all cases all the exhaust passages must be separate from the induction passages, and each induction passage must be separate from all the other induction passages, while each eduction or discharge passage must be separate from all the other discharge passages. The passages thus referred to are the only passages described in the patent, and if they are not so made separate and distinct, each from the other, the meter will not work. This third claim in my opinion includes all the passages, both induction and eduction."

The third claim of the reissue is not, as the appellant contends, a limitation of the first claim of the original patent, but is a restatement or attempted expansion of the sixth claim of the original patent, which involves the piston having the rotary and side-rocking movement of the patent with water passages in it. The form of the claim in the reissue is somewhat different from the form of the claim of the original above referred to, but the substantial difference is that the element of revolving motion which is specifically mentioned in the sixth claim of the original patent is omitted in the third claim of the reissue, although there present by necessary implication as we contend.

Mr. Renwick proceeds (p. 184) : —

"The *fourth* claim is to the combination of the same piston and the same cylinder, having an unequal number of bearing points, and thus producing an eccentric or side-rocking motion of the piston, and dividing the chamber into receiving and discharging spaces on opposite sides of the same diametrical line, when said piston has a free movement in said cylinder, controlled only by the shape of the cylinder, the shape of the piston and the flow of the water through the meter, and I understand this combination to be the combination of the piston and cylinder described, the latter having more points or projections than the former, so as to produce the compound motion of that piston when the latter is uncontrolled by mechanism, which, if used, would prevent the piston from following the prescribed path which is due to its own shape and that of the cylinder. The only passage in the specification which I find bearing on this limitation of the claim is on p. 1, lines 51, etc., which refer to the connection of the piston with the registering mechanism, and is as follows: 'And to accommodate this eccentric or side-rocking motion of the piston, it must have a free or shifting connection with the crank or mover of the registering mechanism.'"

A further passage in the specification which Mr. Renwick overlooked is to the same effect (Record, p. 327) : "It will be seen that the connection of the piston with the registering mechanism is such as to allow of a free or shifting action to accommodate the side-rocking movements of the piston across the centre of the cylinder chamber, and maintain a driving relation with the dial mechanism."

It appears clearly from these passages of the specification that the phrase of the fourth claim, "said piston having a free movement

within said cylinder, controlled only by the shape of the cylinder, the shape of the piston and the flow of water through the meter," refers only to the fact that the connection between the piston and registering mechanism is not rigid, — a construction adopted only because the side-rocking action of the piston in the preferred forms of the Nash meter causes the centre of the piston to travel not in a circle but in an irregular path. If the shaft of the piston travelling in this irregular path were rigidly fixed to the crank of the registering mechanism, every point of which crank must travel in a circle, the piston would be restrained from motion altogether, and the meter be inoperative. This fourth claim of the reissue, instead of being a limitation of the first claim of the original, is in effect a restatement or attempted expansion of the third claim of the original, which is the eighth claim of the reissue, and is for the same combination but in terms limited to a "revolving" piston. The fourth claim of the reissue in view of the specification has no force or meaning other than that involved in the third claim of the original patent, and differs from it only in that it is broadened by the omission of one element, namely, the "revolving motion" of the piston which is stated in terms in the original claim and present by necessary implication as we contend in that of the reissue.

Mr. Renwick proceeds (p. 185) : —

"The *fifth* claim is precisely the same as the fourth, except that it is limited to a piston made of vulcanite or hard rubber, and there is, therefore, no need of any further explanation of the meaning of it."

The only suggestion in either the original or reissue patent upon which the claim to "hard rubber" as an element of the combination can be based, is a casual remark of the patentee, — "I *prefer* to make the piston of hard rubber, *but it may be made of any suitable material*." At the date of the Nash invention hard rubber was a well-known material for pistons of water meters and had been extensively used for that purpose.

(See Read patent, end of appellees' record. Renwick, p. 192, Int. 15; Otis, p. 201; Forsyth, p. 211; all in appellees' record.)

Its characteristics were well known. Its chief advantage for such

use arises from the fact that it wears well and is cheaper than a metal piston of the same size. This fifth claim, like the fourth, is really an attempted enlargement of the third claim of the original patent in the particular above named.

Mr. Renwick proceeds (p. 185) : —

"The *sixth* claim is to the same piston and same cylinder or chamber in combination with each other, the piston having one less projection than the cylinder, so that the former will have a side-rocking motion, and divide the chamber into receiving and discharging spaces on opposite sides of the same diametrical line, when the piston is 'provided with ports controlled by said piston itself, in its motion within said chamber.' Now I have studied the specification carefully, and it will appear from what I have before said, that the specification refers to two entirely different sets of openings as ports, one set being the openings in the cylinder heads J and K, which are the openings bounded by the epicycloidal curves in the heads of the skeleton model. These so-called ports are not properly ports, as they are never controlled or opened or shut by any valve. One of them is an exhaust passage, and always an exhaust passage, always open, and the other is an entrance or induction passage, always open and never controlled at all by the movement of the piston.

The other ports mentioned in the specification are (see p. 2, line 6, of the reissue, and line 126, etc., p. 2 of the reissue) the 'ports *d d'* in the ends of the piston, communicating with lateral passages *e e'*, which communicate with the spaces *c* of the cylinder,' and the statement is that 'the valve is formed within or is a part of the piston, and it consists of ports *d d'*.' These ports *d d'* in the ends of the piston are controlled by the motion of the piston, so as to admit and discharge the water properly from the meter, and these are the ports referred to in the claim, so that the claim in short is to the combination of the piston and cylinder, constructed and operated substantially as described in the patent, with exhaust and entrance ports or openings in the ends of the piston, which are therefore controlled by said piston in its operation, and thereby control both the entrance and the discharge of water. I say both entrance and discharge because the claim expressly states that the receiving and discharging spaces are combined with ports, so that the claim includes both the receiving and the discharging ports in the ends of the piston. The claim does not say in combination with discharging ports alone, or with entrance ports alone, but 'ports' including both."

This sixth claim of the reissue is not a limitation of the first claim of the original, but is obviously an attempted enlargement of the

fourth claim of the original patent, which is for a piston having a side-rocking *and revolving* motion in combination with its valve which opens and closes the receiving and discharging ports when "controlled by the movements of said piston." The specification of both original and reissue (Record, p. 326) states that the "valve" referred to may be either "arranged within the piston as described or separate from and connected with it . . . it being only necessary that the motion of the valve should be *controlled by the compound motion of the piston* in any arrangement."

This alternative construction of valve is equally within the fourth claim of the original patent and the sixth claim of the reissue, and the latter differs from the former only in that it is on its face broadened by leaving out the element of the *revolving* motion of the piston which is stated in terms in the fourth claim of the original patent, but is present by necessary implication as we contend in the sixth claim of the reissue.

Infringement.

There is no substantial controversy in this case as to the actual operation of the appellant's and appellees' meters.

The appellant contends that although the appellees' meter differs from that of the Nash patent in all the particulars above pointed out, yet it is the equivalent of that meter in the features of construction and of operation referred to in the first claim of the original patent, and that it has the details which the appellant says have been appended as pretended limitations to that first claim in the third, fourth, fifth and sixth claims of the reissue.

It is clear that unless in the appellees' meter there is "a piston for water meters, pumps and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides, into receiving and discharging spaces *c c*, which communicate with the inlet and outlet," the ap-

pellees' meter does not infringe, because the structure and mode of operation described in the passage above quoted are essential elements of all the claims upon which the appellant relies.

The appellees contend that their meter has no such construction and mode of operation, and moreover that their meter is not within the claims sued on, because it does not embody the details added in the reissue to the first claim of the original as pretended limitations of that first claim.

The position of the appellant as stated by Mr. Brevoort in his first deposition and repeated in substance in his second deposition is, briefly stated, this: —

Prior to Nash's invention a form of mechanical movement had been devised by Galloway which is shown in his 1843 English patent here in evidence. This mechanical movement was briefly described by Reuleaux in his "Kinematics of Machinery," pp. 433 to 435, here in evidence, where it is called, apparently without warrant, a steam engine. This description is vague, and it is doubtful if it is a sufficient disclosure to defeat a subsequent patent for an operative apparatus. It shows, however, a piston and case constructed and related as are the piston and case of the Nash meter. No porting is described or shown, but it is obvious that the Nash porting might be adapted to it. In this Kinematics contrivance, as in the Nash meter, the piston and case have projections, there being one less projection on the piston than on the case; and the piston has, with relation to the case, a side-rocking movement within and upon continually changing lines across the centre of said case from one bearing point on the case to another, and a motion of rotation about its own centre whereby the case is divided into continually changing, receiving and discharging spaces separated by the continually changing lines across the centre of the chamber which connect the bearing points between the piston and case.

As Mr. Renwick states (p. 178, Int. 6), this Kinematics engine "has precisely the construction and mode of operation of the piston and cylinder or chamber that are described in the reissue in suit."

The Kinematics piston and cylinder have the relative compound motion suggested in the Nash patent as appertaining to modifications

of the structure therein specifically described. The suggestion is as follows (Rec., p. 327) : —

"I have described and prefer in practice that the piston shall have the compound motion described; but it is obvious that the piston may be fixed and the cylinder be made to have the relative compound motion. So in like manner, both the cylinder and the piston may have a separate conjoint motion yet retaining the same relation to each other."

The Galloway 1846 English patent referred to (*supra*, pp. 30–35), was also part of the art at the date of Nash's invention. As already shown "the piston and cylinder of the Hersey (appellees') meter are constructed and operated precisely like the piston and cylinder of the Galloway 1846 engine" (Renwick, p. 187, Int. 15), and the porting of this Galloway engine is substantially the same as the porting of the Hersey meter, as is to be expected.

As Mr. Renwick states (p. 178, Int. 6), "If a proper disclaimer had been made in the reissue, it would have been a disclaimer of this engine in Kinematics, and not of the engine of the Galloway patent, which operates in a totally different way from that of the reissue."

Having by disclaimer introduced into the reissue the new suggestion that the thing disclaimed was embraced in a prior structure like the appellees' meter, and was substantially such as or the equivalent for the Nash structure, the appellant now contends that these two radically different structures are in fact the equivalents each of the other within the meaning of the patent law and that Mr. Nash's real invention lay in certain modifications of the Galloway 1846 structure which are useful in water meters and which the appellant says the appellees have in combination with that structure, — Nash having invented and disclosed them only in combination with his peculiar structure which is like that of Kinematics. It is to be borne in mind that the Galloway 1846 engine is admitted by the disclaimer to be a perfectly operative structure and that no one testifies in this case to the contrary, except a general statement by Mr. Brevoort that no rotary engines are of practical value (p. 48, Int. 37).

Mr. Brevoort sums up the appellant's case as follows (Rec., p. 20, Int. 7) : —

"Thus before the date of the Nash patent two forms of motors or meters were known ; one form, to wit, the form shown in the Galloway patent, which is the form adopted by Tilden, and another form, to wit, that shown in the 'Kinematics of Machinery,' also invented by Galloway, in which the projections of the piston and the case were not alike in number, and giving a piston which in operation rotated on its own axis, and which is the form of mechanism adopted and improved by Nash to make a commercial meter. Now, disregarding what Nash did, the state of the art clearly shows that the form of meter or motor in which the piston revolved on its own centre as it moved eccentrically in the case was a well-known equivalent form for that structure in which the piston moved eccentrically in the case, but did not revolve on its own centre. From this state of the art I have no hesitation in saying that outside of the improvements of Nash, the Tilden mechanism and the Nash mechanism are the same."

Again he says in the same answer, page 21 : —

"As a matter of fact Nash took one form of the Galloway engine (which we may designate the Galloway Kinematic Engine) and added certain improvements to it, and thus made a meter of commercial value, while Tilden took the other well-known form of the Galloway engine (which we may designate the Galloway Patented Engine) and taking Nash's improvements, added them thereto and made a meter precisely like Nash's, except that the form of Galloway engine selected was not the form selected by Nash, though the improvements added thereto were precisely the improvements which Nash added to the form of Galloway engine selected by him."

Mr. Brevoort's fundamental error is in assuming that the Kinematics or Nash and the Galloway or Hersey structures are "equivalents" in the sense of the patent law.

It is true that the appellant's Kinematics device and the appellees' Galloway device produce the same ultimate result, that is, each, when combined with porting peculiar to it, and not adapted to the other, serves to measure or pump water, or acting as an engine to transmit power. This does not make them equivalents, except in the sense in which a horse, and a locomotive, and a water wheel, and an electric motor may be said to be equivalents.

An examination of the authorities will show that the courts have declined to apply the doctrine of equivalents to any such state of

facts as are here before the Court. When two devices are of a different character and operate in a different way, the fact that the result produced is the same in each case does not make them equivalent. The authorities on this point and the rules of law established by those authorities will be considered later (pp. ~~77-83~~ 82-86 of this brief).

But a complete answer to Mr. Brevoort's position is found in the fact that the terms of the claims of the Nash reissue limit his invention to a certain definite structure, relation and mode of operation which the appellees do not employ. Nash does not claim in this case any rotary meter embodying the improvements in which Mr. Brevoort says his invention lies, and which appear in the reissue as addenda to the first claim of the original. The claim itself requires that the piston should be "eccentric or side rocking" "within and upon continually changing lines across the centre of said chamber," and that by means of this side-rocking movement a division of the chamber should be effected "at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet," — features which the appellees' meter does not have. Moreover, the specification sets out that a compound motion of the piston is required to secure the operation so claimed, and without this compound motion such results would not be possible. The appellees' piston has no such compound motion. The specification points out with emphasis that this necessary compound motion is impossible unless certain definite features of construction, namely, one less projection on the piston than on the case, and a piston small enough and properly shaped to revolve as well as to side-rock, are present. Appellees' meter has the same number of projections on piston and case, and the piston is not so shaped or sufficiently small to revolve in the case.

Before dealing with the clause of the claim above quoted, it may be well to recapitulate briefly, and in view of the above descriptions of the Hersey meter and the appellees' meter, the requirements of the specification of the reissue which are characteristic of the Nash structures, but are not present in the appellees' meter.

Nash Patent.	Hersey Meter.
The patent requires that the patented piston should have an "eccentric or side-rocking motion across the centre of a cylinder chamber to effect its division at two or more points into receiving and discharging spaces."	The appellees' piston has no such motion and the cylinder chamber of appellees' meter is not divided by the piston "at two or more points into receiving and discharging spaces" in the sense of the Nash patent.
The patent requires that "with this eccentric or side-rocking action the piston also revolves round its own centre . . . for as the piston rocks from one bearing point to another directly across the centre of the cylinder it is at the same time revolved."	The appellees' piston has no motion of revolution about its own centre.
The patent requires that "in the rotation of the piston around its own centre one or more projecting bearing points of the piston will pass into corresponding recesses at one point of the cylinder, and in contact with and over one or more projecting bearing points of the cylinder at a different point, thereby always maintaining a direct contact of the piston and cylinder at two or more dividing points within the continually changing cylinder spaces."	In the appellees' meter the bearing points of the piston are always in their own special recesses in the case and are never in contact with and never pass over any of the projecting bearing points of the cylinder, and in the appellees' meter there is never a direct contact of the piston and cylinder at two or more dividing points within the meaning of the Nash reissue.
The patent requires that the valve should be "arranged so that the cylinder spaces on one side of the piston as it revolves have free inlet of the water through one set of the valve ports while the spaces on the other side of the piston have free outlets for the water through the other ports of the valve."	In the appellees' meter the division between the inlet and outlet ports is not made by the piston, but by individual projections of the piston, all the displacement of the water being effected in the individual chambers of the cylinder, and no two chambers ever being connected while measuring water.
The patent requires that the valve should so open and close the ports in succession "as to keep the line of pressure of the water as nearly as possible at right angles to the direction of the eccentric or side-rocking and rotary movements of the piston, and thereby avoid any undue lateral pressure of the water upon the piston."	In the appellees' meter the motion of the piston is of an entirely different character and the very "lateral pressure of the water upon the piston" which the Nash structure is designed to prevent is an essential feature of operation. Without it the piston of the appellees' meter could not be kept up against the side of the case and no water could be measured.

Nash Patent.	Hersey Meter.
The patent requires that when a separate valve controlled by the piston is not employed, the valve is "formed by inlet and outlet openings or ports in the ends of the piston communicating by means of passages in or through the piston with the spaces of the cylinder."	In the appellees' meter no separate valve is employed but there are no ports in the ends of the piston and no passages in or through the piston which communicate with the spaces of the cylinder. The single passage in the centre of appellees' piston is a portion of the discharge pipe and as shown (*supra*, p. 27) it is only required in order to accommodate the water discharged at the bottom of the meter, — a double discharge, namely, at the top and bottom of the meter, being used for the purpose of balancing the piston.
The patent requires that the piston and cylinder should have "bearing or contacting surfaces . . . formed by alternate recesses *a a'* and projections *b b'* of such form and configuration as to allow of the rotation of the piston not only upon its own axis but around and across the centre of the cylinder, and the space within the cylinder must be of such form and sufficiently larger than the piston H to allow it to have this compound motion."	In the appellees' meter the projections and recesses are of such form as to prevent the rotation of the piston upon its own axis, and also to prevent its motion around and across the centre of the cylinder, and the space within the cylinder is not of such form and sufficiently larger than the piston to allow it to have this compound motion.
The patent states that "the object of this compound motion is to form bearing points or lines of contact of the piston with the cylinder walls on opposite sides thereof at the same time as shown in Figs. 3 and 12, whereby to divide the cylinder into receiving and discharging spaces."	In the appellees' meter no bearing points or lines of contact of the piston with the cylinder walls on opposite sides thereof at the same time are formed, and the receiving and discharging spaces are differently situated and divided in an utterly different way and on different lines
The patent requires that "of whatever form these alternate recesses and projections, they must be such that while they are in contact upon one side of the cylinder they must also at the same time have a contact at the opposite or a different side of said cylinder, and in this way divide the cylinder into spaces."	In the appellees' meter the projections and recesses are of such form that this required mode of dividing the cylinder into spaces by contacts on opposite or different sides of the cylinder is impossible.
The patent requires that "in this contact it will be observed that upon one side of the cylinder and piston such	In the appellees' meter no contact such as is thus required ever takes place, and there is no contact upon

Nash Patent.	Hersey Meter.
contact takes place between a recess and projection or intermediately between these points while upon the opposite side such contact is made by corresponding projections, as shown in Figs. 3 and 12."	opposite sides of the cylinder. In each particular chamber receiving and discharging spaces are formed by the projection of the piston which is in that chamber in the beginning and which never leaves it.
The patent states that "the compound motion of the piston and the contacting dividing points are due to the fact that the piston has one or more less points of projection than the cylinder."	In the appellees' meter there are the same number of projections on the piston as on the cylinder and consequently no compound motion of the piston is possible.
The patent states that the function of either form of valve described "is to regulate the flow of the water in and out of the spaces of the cylinder in such manner as to produce the compound rotation and cross movement of the piston."	In the appellees' meter the water is let in and discharged in such a way as to prevent any movement of the piston except a sliding movement which is neither a compound rotation nor cross movement within the meaning of the Nash patent.
The patent requires that the valve and piston should "co-operate to produce the result stated," viz., the compound motion of the piston and the proper control of the flow of the water in and out of the spaces of the cylinder.	In the appellees' meter the valves are adapted to the peculiar motion of the appellees' piston and the peculiar separation of discharging and receiving spaces characteristic of that meter, and not at all to any such structure as is required by the Nash patent.
The patent requires that to get the best result "the valve should open and close its inlet and outlet ports in succession in such a manner as to keep the line of pressure as nearly as possible at right angles to the direction of the motion of the piston." And the patentee explains: "By the 'line of pressure' I mean a line connecting the points of division which separate the inlet from the outlet spaces c of the cylinder, as shown by the line z in Fig. 12; and by a 'line of motion' I mean a line which is tangent to the path of the axis of the piston at any point of such path as shown by the arrow y in said figure."	This requirement, interpreted by the definitions given, has no meaning when applied to the appellees' meter.

Nash Patent.	Hersey Meter.
The patent states that "in the use of the meter the inlet may become the outlet and *vice versa*."	In the appellees' meter the inlet must always remain the inlet and by no possibility can it become the outlet. The Nash meter may be run in either direction. The appellees' meter would be entirely inoperative if the inlet became the outlet and *vice versa*.

Mr. Renwick in his answer to Int. 15, page 186, points out all these differences and declares that they are inherent in the radically different structures of the two meters. He also points out (p. 188) the following further differences which serve to distinguish one meter from the other: —

(p. 187 this record)

(p. 179 this record)

"*Fifthly.* All the points of the Nash piston describe the same curve following each other in succession over the same line as shown in" the diagram opposite p. 8 of defendants' record; "whereas, on the contrary, in the Hersey meter," as shown in the diagram opposite p. 21, "in which the red circles show the motion of the piston points, it will be seen that each point of the piston describes its own curve and that no other point of the piston ever traverses that curve."

"*Sixthly.* The curve described by all the points of the Nash piston is epicycloidal; the various curves described by each one of the points of the Hersey piston are circles."

"*Seventhly.* None of the curves described by the points of the Hersey piston surround or enclose the centre of the piston or case whereas the single epicycloidal curve described by all the points of the Nash piston does surround and enclose the centre of the piston and chamber."

Mr. Renwick explains fully the reason why the extra lateral pressure is required in the Hersey meter to keep it up to its work, and why such lateral pressure has no function and is to be avoided in the meters of the Nash patent. He also explains the radical difference between the method in which the discharging and receiving spaces are developed in the two meters, and proceeds (p. 190) as follows: —

"Now I think it will be evident from this that the time and order of controlling the valves in the defendants' meter must be entirely different from the time and order of controlling the valves in the plaintiff's meter, and consequently that the valve ports must be differently arranged with reference to the valve or valves which open and close those ports, and that there is a pressure of water in the

defendants' device which is not found in the plaintiff's and that the defendants' meter is operative at all solely by reason of this pressure."

He then shows that the appellees' meter wears tight while the appellant's meter, which depends for its fit entirely upon its original construction, does not wear down to a fit in the same way.

As already stated (*supra*, p. 17), Mr. Brevoort contended in his first deposition that the words "eccentric or side-rocking" in the plaintiff's patent meant two different things, and that while all the structures of the appellant's patent were eccentric those shown in Fig. 10 and 11 were not side-rocking (Brevoort, Cross-Int. 9), although he admits (p. 22, Cross-Int. 11), that he finds no justification for this distinction, and in Cross-Ints. 13 to 16 admits also that in all the figures of the patent "one side of the piston is moving faster and through a greater space than the approximately opposite point," and that his only reason for distinguishing between the two words is that "I see no object in defining the motions of the various pistons by two terms unless they were used to express the differences between the motions which the pistons of the various meters of the patent had." He further admits (p. 24, Cross-Ints. 24 and 25) that the appellees' piston has not the side-rocking movement of the Nash reissue or any side-rocking movement whatever. He does, however, insist that it has "an eccentric movement," and also states (p. 24, Cross-Int. 27) that all of the Nash structures have a like eccentric movement.

Mr. Renwick's testimony, showing from the patent itself that Mr. Brevoort is wrong in his attempted distinction between "side-rocking" and "eccentric" (Renwick, p. 182, Int. 7), has already been pointed out (*supra*, pp. 17, 18).

It seems perfectly clear that the appellees' piston has no such "eccentric or side-rocking motion" as is described in the Nash patent and required by the claims, and that therefore it is an utterly different structure from that there patented. This we submit is the only important consideration. It is certain, however, that as stated by Mr. Renwick "eccentric action means side-rocking and side-rocking means eccentric action" in the patent, and that therefore the appel-

lees' piston having as Mr. Brevoort admits, no "side-rocking" action within the meaning of the patent, has not the "eccentric" action of the patent. Mr. Renwick states: —

"The Hersey meter has not the eccentric or side-rocking motion described in the Nash patent, and has no eccentric motion at all in any ordinary sense of that word. It has precisely the same motion as the connecting rod which connects the two driving wheels of a locomotive engine. Every point in that connecting rod will describe a circle of the same diameter and none of the circles described by the various points will be concentric, and this is exactly the case with the Hersey piston. Every point in it will describe a circle of the same diameter that any other point will describe, and no two of these circles will be concentric. A connecting rod such as I have described has no rotation on its own axis and no eccentric motion, neither has the Hersey piston." (Renwick, p. 188, Int. 15.)

The appellants in Mr. Renwick's cross examination (p. 198, Cross-Ints. 40–45), and in Mr. Brevoort's rebutting testimony (p. 38, Int. 12), undertake to show that as a matter of words the motion of the appellees' piston may be called "eccentric." They base this view largely upon the fact that the Hersey piston, like the connecting rod of a locomotive, could be driven by a properly constructed eccentric. We submit that Mr. Renwick is clearly right in his contention, but that the point is entirely immaterial. The question before the Court is simply what is meant by the phrase "eccentric or side-rocking motion" in the appellant's patent, and whether or not the appellees' meter has the motion described by that phrase. No one in this case pretends that the piston of appellees' meter has any such motion as that shown and described in the Nash patent, and referred to in the claim as "an eccentric or side-rocking motion."

In *Kittle* v. *Merriam* (2 Curt. 479), CURTIS, J., said: —

"But in construing a claim we cannot look to a single phrase only, to the exclusion of all the residue of the writing. On the contrary, we must look at the entire specification and drawings, and view each part by the light thrown upon it by the whole."

In *Union Paper Bag Co.* v. *Nixon* (6 Fish. 407), EMMONS, J., said: —

"Words identical should be rendered as diversely as the conditions in which they are employed demand, in order not to defeat the fairly presumed intention of those who use them."

Even if Mr. Brevoort is right in believing that the motion of appellees' piston might be *called* "eccentric" this cannot affect the admitted fact that that motion is not the one to which Mr. Nash gave the designation "eccentric or side-rocking." See Brevoort's cross examination p. 61 to 65, Cross-Ints. 133 to 156. It is to be observed that in his rebutting deposition Mr. Brevoort doubts the accuracy of his distinction between the words "eccentric" and "side-rocking" (p. 57, Cross-Ans. 101, 102).

Mr. Brevoort nowhere questions the fact brought out by Mr. Renwick, and clear from the patent itself, that in the Nash meter the receiving and discharging spaces must be formed by contact between the piston and cylinder on lines across the case, and that the "compound motion" of the piston is essential to this operation and to all forms of meter described in the Nash patent; nor does he deny that the appellees' meter is utterly different from that of the Nash patent in these particulars, as well as in the other important particulars pointed out by Mr. Renwick.

The appellant's only answer to the appellees' case is based upon a series of models which have been produced, not as representing either the appellant's or appellees' structure, but as tending to show that new forms of meter may be devised which will partake of some of the characteristics of the Nash structure and of some of the characteristics of the appellees' structure. The appellees have one general answer to make to all these hypothetical contrivances, which is, that they prove nothing material to this case and throw no light upon the relation existing between the appellees' meter and that of the appellant's patent.

Having two independent and utterly distinct contrivances before him, a skilful mechanic like Mr. Brevoort or an ingenious inventor

like Mr. Nash can readily devise new intermediate forms of mechanism which have a superficial resemblance in part to one of the old devices, and in part to the other. Such intermediate forms developed in view of both of the older forms do not tend to show in the slightest degree that the two forms upon which the new one is based are substantially alike, but on the contrary tend to emphasize the difference between them. We believe that this is the case with Mr. Brevoort's hybrid models here in evidence.

The first models introduced in evidence by Mr. Brevoort in his second deposition are described by him in his answer to Ints. 3 and 4, pp. 34, 35 of the record. By these models, marked "K," he undertakes to show that in appellees' and the appellant's contrivances "there is no difference in the displacing action, the piston in both conditions passing through the same space and displacing the same quantity of fluid." It is obvious that this model does not illustrate even remotely any of the contrivances here in issue and throws no light upon the question of the relation between those contrivances. Both when he holds the piston K stationary, and when he allows it to revolve on its centre while it is also travelling in its circular path in its case K, Mr. Brevoort shows only that a body travelling in a given path will get to the end of its journey whether it does or does not revolve at the same time. In neither case does he show anything as to the peculiar actions of the appellant's and appellees' structures in which the motions of the piston which characterize each, are essential to it because of the peculiar displacement principle employed with the porting and division of case or chambers required for the application of that principle. The model K is not a meter in any sense, and in neither of Mr. Brevoort's illustrations is there any displacement whatever exemplified. The piston of that model moves through the water exactly as does an oar upon the surface of a river displacing nothing in the sense in which that word is used in connection with meters. No displacement is possible unless there are inlet and outlet ports which enable the water to be received and discharged properly. There can be no meter without displacement chambers properly connected with such inlet and outlet ports. Moreover the difference between the motions

of appellant's and appellees' pistons is not merely that one rotates and the other does not. The Nash piston *side-rocks* as well as revolves. The appellees' piston *slides bodily*, and neither side rocks nor revolves. See *supra*, pp. 25–28. We submit that Mr. Brevoort's model K throws no light on this case.

The next models produced by Mr. Brevoort are described by him in his answer to Int. 5, p. 35, of appellant's record. Here he undertakes to show that there are certain *new and original* forms of meter, devised by his ingenuity and that of Mr. Nash, which resemble meters of appellant's patent in certain particulars and the appellees' meter in certain other respects. He first produces a model made up of piston "N," which, he says, has the Nash water passages in it, and a cylinder which has head plates marked "N," which head plates have inlet and discharge openings of the same character as those of the head plates of the Nash patented meter. When the piston "N" is moved about by hand in the case having heads "N" it does not rotate upon its centre but may be made to move in a path somewhat similar to that of appellees' piston. By this model Mr. Brevoort undertakes to show that appellant's porting may be adapted to appellees' piston and principle of displacement. His second combination model is made up of appellees' piston, taken from Exhibit "D" and a case "M" which is specially made for it. This case has what Mr. Brevoort calls the "appellees' portage," and with this combination the piston revolves as well as travels about the case. Mr. Brevoort argues from these two models that the "rotation of the piston on its own axis is not a point of difference that is either substantial or material, for they show that one form with one kind of portage and the other form with the other kind of portage can be successfully used."

The appellees have never undertaken to deny that it might be possible to adapt the portage of the Nash meter to a piston having the motion of the appellees' meter and *vice versa*, or that many forms of meter may be devised which will partake of characteristics, some of one and some of the other type of meter. But we regard this whole matter as immaterial. It is quite possible that after one

type had been developed and patented by Mr. Nash and the other type developed and patented by Mr. Tilden, a competent inventor could devise numerous intermediate contrivances partaking of the characteristics of each. This would not tend to show that the original forms are substantially the same in fact or within the meaning of the patent law.

Mr. Brevoort's attempt to establish that proposition in this way serves to bring out clearly the substantial and material differences between the structures, and fails utterly, as we contend, to show that those original structures are at all alike.

Considering first the piston "N" with its case having on its head plates "*N*," we find that the porting of that piston is substantially unlike that of the Nash piston. There are to be sure passages in the piston which occupy somewhat the same relation to the piston and to each other as those shown in the Nash patent. Mr. Brevoort testifies unequivocally (p. 52, Cross-Ints. 63, 64) that they are the same as those shown in Figs. 1, 2, 3, 4 and 5 of the Nash patent except that "the ports seem to be somewhat smaller in proportion." He, however, is forced to admit, in his answer to the succeeding interrogatories (Cross-Ints. 65–84), that while in the Nash piston the inlet and outlet holes are in circles about the centre of the piston, which circles are of substantially the same diameter and directly over each other; in the model N the diameter of the circle of outlet passages at the top is very considerably larger than the diameter of the circle of inlet passages at the bottom. (Cross-Ints. 67–69.) At first he is not able to state why these ports are so arranged as he had "never considered the difference a material one" (Cross-Int. 71); and he has no opinion whether this variation from the Nash structure is or is not important, not being able to know "because he has never tried it" (Cross-Ints. 72–75). Finally in Cross-Ints. 77 and 78 he suddenly discovers that "the ports on the lower side are constructed *so as to bring more into action at once*," and that the reason for this is because it is necessary that there should be a fourth inlet port always open, leading into a chamber from which there is no water discharging in order to "*keep the piston up to its work.*" That is to say, the model "N" introduced by the appellants to show

the similarity between the appellees' and the appellant's structures and which purports to have the porting of the appellant's patent, has its porting *substantially different* from that of the appellant's patent because the use of the appellant's porting is entirely inconsistent with the actions of the appellees' piston.

As already pointed out, an essential feature of the appellees' meter is that there shall be not merely the water pressure which moves the piston about in its case but the additional "*side pressure*" which the Nash patent says in terms must be avoided in his structure, for unless there is such additional "side pressure" the appellees' piston would not be kept up against the side of its case. In the Nash structure the opening of a fourth inlet passage while only three discharge passages are open would destroy the efficiency of his meter. The opening of a fourth passage in the combination model "N" introduced by Mr. Brevoort is *absolutely essential* to get the "side pressure" required in the appellees' structure but to be avoided in the appellant's.

For this reason the entrance ports in piston "N" are drawn together and must be drawn together in order to have continually uncovered one more inlet than discharge port, whereby the side pressure may be attained.

Again the Nash patent expressly states that the meter of the patent may be run in either direction. That is, that the direction of the water through the meter and the motion of the piston may be reversed without affecting the successful operation of the meter. This is not true of the combination model "N" as Mr. Brevoort is obliged to admit (p. 55, Cross-Ints. 93–96), and as already shown, is not true of appellees' meter. This difference is an important one, emphasizing the fact that the appellant's and appellees' meters are constructed and operate upon such absolutely different principles that even when what Mr. Brevoort called "the Nash porting" is applied in appellees' meter, that meter still retains its distinguishing characteristics and will not operate as does the Nash meter.

Again Mr. Brevoort admits that appellees' meter Exhibit D would

be in his opinion equally operative if the inlet holes were in the walls of the case and not in the plate at all; that is to say, that it is a matter of no consequence whether or not the inlet ports are ever covered by the bottom of the piston. (Page 66, Cross-Int. 175.) This, of course, is not true of the appellant's meter, in which the lower ports in the bottom face of the piston, each must be successively closed at the proper time in order to prevent the inflow of water into chambers that are then discharging. Inasmuch, however, as in combination model N the chamber is divided into receiving and discharging spaces, not upon the principles of the Nash meter but upon those of the appellees' structure, it is not necessary that the inlet ports in the bottom of the piston should ever be covered up at all, but the meter would be equally operative if all the inflowing water was received into a cavity in the bottom of the piston and flowed continually through any and all of the inlet passages; for in that case part of the water would flow into the then existing receiving chambers where it is to be metered as usual and the rest would simply flow into the neutral space on the opposite side of the cylinder from that at which the receiving and discharging spaces were then forming and would be employed to keep up the side pressure which is essential to a structure having the characteristics of the appellees' meter. (Brevoort, p. 67, Cross-Int. 188.) In spite of the adaptation to it of the Nash porting, combination model N has the principle of displacement and the mode of operation of the appellees' meter and cannot be assimilated in any way to the Nash structure.

The piston N itself bears evidence of the care necessarily used in its construction in order to get any results whatever. The piston shows that the holes on the outside of its periphery were originally drilled in the wrong place and had to be bored over again. This was because they were at first so near the ends of the projections that the meter would leak from one chamber to another, whereby its efficiency would be destroyed.

It is respectfully submitted that the combination of piston N, case D and heads N, does not tend to show any resemblance between the appellant's and appellees' types of meter, but on the contrary emphasizes the radical differences between those types.

The second combination model made up of the appellees' piston D with case marked "M" having porting resembling that of the appellees' meter, is supposed by Mr. Brevoort to illustrate the fact that a meter may be devised which will have porting and receiving and discharging spaces like those of the appellees', but which will rotate upon its own centre. The appellees do not controvert this proposition, although we deny that it is proved by this combination model. But here again, the fact, if proved, is immaterial. The model made up of piston D and case M is neither the appellant's meter nor the appellees' meter. It resembles the appellant's meter in that the piston revolves about its centre. It resembles the appellees' meter in that the receiving and discharging spaces are made in the cylinder chambers and not by lines across the centre of the case. But this combination model, case M and piston D, does not satisfy any of the requirements of the Nash patent. The points of the piston do not pass over or bear upon the points of the case. The piston *slides* and *rotates;* it does not *side-rock* and *rotate* as do the pistons of the Nash patent. Mr. Brevoort (p. 57, Cross-Ints. 101, 102) admits in substance that the piston in this model does not side-rock.

The projections on the piston divide the individual chambers successively into receiving and discharging spaces, while the Nash patent requires that the receiving and discharging spaces should be divisions of the cylinder formed on lines across the centre of the cylinder.

If the appellees were using a meter like that made up of case M and piston D, we should confidently contend that they were not infringing the Nash patent. They are not, however, using any such contrivance, and this combination model differs from what the appellees actually use in all those particulars in which such model resembles the meter of the Nash patent.

Moreover, even in this instance, the appellants were unable to adapt the piston of appellees' meter to a case in which it would rotate without a substantial alteration in the device.

Mr. Brevoort is asked (p. 71, Cross-Int. 219) to put together appellees' piston D and the parts of case M. He is unable to do so

because the orifice in the top of case M is not large enough to permit the spindle of the piston to pass through it. Again in appellees' meter the top head plate is open at the centre, while it is closed in the case of the head plate of M and the bottom in case and heads M is open in the centre and the corresponding plate is closed in appellees' Exhibit D. (Brevoort, pp. 71–72, Cross-Ints. 219, 223.) The reason for these changes in a structure which is supposed to be based upon appellees' meter is correctly stated by Mr. Brevoort (p. 72, Cross-Int. 224) to be "because if the hole in the top was big enough to allow the central spindle to work the registering mechanism in Exhibit M, the hole would have been so large as to open some of the neutral chambers," when the water would flow from them directly into the outlet. For this reason the model had to be carefully reorganized, and on this ground alone we should contend that it can prove nothing.

It is to be observed that neither of these combination meters has actually been tested to see how it will operate. All that appears on the subject in the record is that Mr. Brevoort referring alike to each of them says "I put on the stream and saw that it rotated properly. I did not attempt to measure its accuracy as a meter. (Page 71, Cross-Ints. 217, 218.)

It is submitted that by the same process of reasoning as that adopted by Mr. Brevoort, almost any two machines could be shown to be alike, for all machines are analagous in certain particulars and it is possible in very many cases to develop a number of intermediate forms between machines of substantially different types. Many new and important inventions are made up by bringing together the good points of several distinct machines and organizing them properly into an operative combination.

Mr. Brevoort attempts, in his answer to Int. 12, p. 38, to show by models P, O, V and W, that the appellant's and appellees' meters may be driven by an eccentric, and argues that for this reason they may be said to have an eccentric motion.

We have already undertaken to point out that this whole discus-

sion is entirely immaterial, and can serve no useful purpose in this case.

But neither of the pistons and cases used by him are like the appellees' or any of the appellant's meters, and while it is true that any form of appellees' pistons could be driven by an eccentric inserted in it, for the reason that, as has already been shown, *every point on it moves in a circle*, it is equally true that only a carefully selected and designed form of Nash piston could be so driven, namely only a form whose centre traversed an exact circle. (Brevoort, pp. 63, 64, Cross-Ints. 144½, 145.)

The eccentric to drive the appellees' piston might be away from its centre (Brevoort, p. 63, Cross-Ints. 142, 143), but in the selected Nash structure it would necessarily be exactly at the centre. (Brevoort, pp. 63, 64, Cross-Ints. 144, 145.)

Any piston that could be driven by an eccentric, as arranged by Mr. Brevoort, could be driven by a crank. (Brevoort, p. 62, Cross-Int. 134.) Would it, therefore, be proper to define the motions of the Nash and Hersey pistons as crank motions? We submit that, strictly speaking, a crank motion is a motion caused by a crank, and an eccentric motion one caused by an eccentric and its strap. Mr. Brevoort says (p. 39, Int. 12) that in his opinion "a motion obtained from an eccentric pulley must be said to have eccentric motion." We agree with that statement, but if the eccentric pulley is not present, we contend with Mr. Renwick that "eccentric motion" ordinarily refers to a motion "produced by means of an eccentric strap and rod." (Renwick, p. 198, Cross-Int. 44). Of course this discussion is immaterial and dealing only with words. The important thing is that in the Nash patent, the "eccentric motion," is the same as the "side-rocking motion" so clearly described. This last proposition seems too clear for controversy. (See *supra*, pp. 17, 18.)

The other models produced by Mr. Brevoort may be more briefly dismissed. In his answer to Int. 6, page 36, he produced Brevoort models O, P, Q and R, to show that certain forms of piston unlike

in shape either the appellees' or any of the appellant's structures may be adapted to co-operate with forms of case unlike in shape to any of the appellant's cases, so as to have the movement of the appellant's piston, and may be furnished with a case unlike in shape to the appellees' case in which they may have the motion of the appellees' piston.

These models, again, can prove nothing except the capacity of Mr. Nash and Mr. Brevoort to devise new and patentable forms of meter based upon the older forms with which they are familiar. Again the piston Q in case O never side-rocks. Its projections do not pass over the projections on the case, and it does not divide the case into receiving and discharging chambers such as are required by the Nash patent. In this illustration neither the structure of the Nash patent nor that of appellees' meter is represented, but a new type differing in substance from either. We think it clear that Mr. Brevoort has failed entirely in his attempt to show that the appellant's and appellees' structures are equivalents in the sense of the patent law, and that the models by which he endeavors to support his argument serve only to establish the contrary proposition.

The substantial differences between what Mr. Brevoort calls the Kinematics form and the Galloway 1846 form of structure are referred to by him in many parts of his deposition. On page 56 he is asked the following question (Cross-Int. 97): "You have referred several times to differences in portage characterizing the two types of meter movements, the Galloway 1846 patent, to which the appellees' meter belongs, and the 'Kinematics' type, to which the Nash meters belong. Will you please recapitulate those differences?" His answer before the adjournment was as follows: "Those differences which are necessitated by a rotating or a non-rotating piston, that is, a piston rotating on its own centre. A rotating piston as in Fig. 12, may have three connected chambers open at one time to the incoming water, while in the non-rotating meter adjacent and not connected chambers are opened to the inflow. In the non-rotating meter the water pressure must be on the neutral chambers." After

the adjournment he undertakes to qualify this answer, but not successfully, as we think.

We believe that a careful reading of Mr. Brevoort's second deposition will show how unsubstantial are the grounds upon which he relies to show infringement. On the other hand, we believe that the views and arguments advanced by Mr. Renwick are sound and impregnable.

THE ADDITIONAL ELEMENTS INTRODUCED INTO THE FOUR CLAIMS OF THE REISSUE UPON WHICH THE APPELLANT RELIES, NOT FOUND IN APPELLEES' METER.

The appellees' meter, as already shown, does not embody the structure and combination of devices which formed the subject matter of the first claim of the appellant's original patent; and inasmuch as that entire structure and combination of devices appear as an essential element in each of the four claims of the reissue relied upon by this appellant, it follows that none of those four claims are infringed by the appellees' meter. The appellees rely, as an additional ground for sustaining their allegation of non-infringement, upon the fact that the *appellees' meter does not even contain those features which were introduced into the reissue for the express purpose of bringing that meter within the scope of that reissue.*

The third claim of the reissue requires as an additional element that the piston must be provided with internal water passages. The only internal water passages of the appellant's reissue are the inlet and outlet ports passing respectively from the bottom and top of the piston through its body to chambers in its sides, there being one inlet and one outlet passage for each recess of the piston.

As Mr. Renwick states (p. 184, of the record, Int. 9), "in all cases all the exhaust passages must be separate from the induction passages and each induction passage must be separate from all the other induction passages while each eduction or discharge passage

must be separate from all the other discharge passages." . . . If these passages "are not so made separate and distinct each from the other the meter will not work. This third claim, in my opinion, includes all the passages both induction and eduction." In the appellees' meter Exhibit D there are no such passages and no passages of any sort. There is one single passage passing from the centre of the piston, which is really a portion of the discharge pipe, into which central passage, as already described, the discharge orifices in the bottom and top plate of the meter empty, and which leads directly to the discharge pipe leading from the meter.

Mr. Renwick thus describes the character of this single passage in the appellees' meter, and its relation to the third claim of the appellant's reissue (p. 190, Int. 15) : —

"I have before stated that there were passages, each separate and distinct from the other, some for the entrance, some for the discharge of water, in the piston of the plaintiff's meter. There are no such passages in the piston of the defendants' meter. The defendants' meter has one single opening through the centre of the piston, and this opening is not a passage controlled by ports and valves, sometimes open and sometimes shut, like the plaintiff's passages, but is always open, and all the water discharged by the meter is continually passing through it. The mode of operation of this passage is entirely different from the mode of operation of any one or all of the passages in the piston of the plaintiff's meter.

Moreover, an exhaust passage always open through the centre of a revolving piston was not new in the Hersey meter. It may be seen in the patent granted to Chapman, November 12, 1867. It is true that this patent is for a rotary steam engine, and that exhaust steam instead of exhaust water passes through it, but the claims of the plaintiff's patent in suit are not limited to a meter, but include motors which are steam engines. In the Hersey meter, Chapman's device is used, and the passages of the Nash patent are not used. Chapman also shows a passage for the entrance of steam through a rotary piston, but this passage does not act like plaintiff's passages, as it is always open and not controlled by a valve like the plaintiff's passages are."

The Chapman device is only material in this case because it shows clearly and distinctly that, prior to Nash's invention, it was old to have a passage in the piston of a rotary engine through which

fluid passed. In this respect it cannot be denied that the Hersey meter is like the Chapman, and not like the Nash contrivance.

Mr. Brevoort's comments upon this Chapman device (p. 48, Cross-Ints. 39, 40), are immaterial. The attempt of Mr. Brevoort (p.46, Int. 30) to show that the porting of the appellees' structure only differs from that of the appellant's in that the parts are reversed, requires no answer other than the full description of the two mechanisms hereinbefore contained. "Exhibit Y," p. 46, by means of which he illustrates this proposition, shows only a superficial resemblance in immaterial particulars between a sectional diagram of appellees' meter and a sectional diagram of appellant's meter in which substantially all the important features of each meter on which its operation depends are carefully suppressed. The question of porting, displacement and division into receiving and discharging chambers are intimately involved and cannot be separated or ignored in considering the true character and construction of a water meter. The mere consideration of a carefully selected sectional view might serve to confuse but cannot possibly prove anything.

The fourth claim involves as an additional element the idea that the piston shall have a free and uncontrolled movement. In the passage from Mr. Renwick's deposition already quoted (*supra*, pp. 38, 39) he shows clearly that the only "free and uncontrolled movement" of the piston contemplated by the Nash patent is that which is involved in any meter like those of his patent in which the centre of the piston travels in an irregular path and not in a circle. As the patent states, "to accommodate this *eccentric or side-rocking* motion [that being the reason why the centre of the piston travels in such an irregular path], it must have a free or shifting connection with the crank or mover of the registering mechanism." The centre of the appellees' piston, as already shown, travels in an exact circle and therefore the appellees' meter does not have the combination of the fourth claim because it does not have a free and uncontrolled movement for the reason or in the combination specified in the appellant's patent.

We contend that in view of the complainant's specification an

eccentric or side-rocking piston is involved in the phrase "free movement" in the claim, even if it were not specifically required by the other portions of the claim already referred to.

Mr. Renwick (p. 191, Int. 15) testifies: —

"When two revolving parts in a machine are connected together by a crank as the counters are connected with the pistons in both plaintiff's and defendants' meters, it has been customary for at least thirty years, to my knowledge, to let the crank pin enter into a slot in the crank of the driven mechanism, or to connect the driven mechanism with the crank pin by means of a drag link, and either of these plans would be substitutes for the mode of driving the counters or registers in both the plaintiff's and defendants' meters, but it is not necessary to go into the general state of the art to invalidate a broad claim for any and every kind of a rotary piston which is uncontrolled by a crank or other mechanism and is free to take the position into which it is forced by the entering water or steam. The patent to Galloway of 1846, as I have before stated, describes a piston and cylinder like the defendants' and operating in the same way, and its piston drives mechanism by means of a crank, and the piston is not at all controlled by the crank, but can take the positions due to the operation of the steam upon the piston. In this Galloway engine, as will appear by reference to Figs. 5 and 6 of the patent, the hole in the piston is of considerably greater diameter than the crank pin. Consequently the crank pin does not fit the hole, and the piston can describe a different circle from that described by the crank pin. Consequently the piston is uncontrolled, as the defendants' piston of the same kind is, and has a free movement within its cylinder, controlled only by the shape of the cylinder, the shape of the piston and the flow of steam through the engine. This crank pin of Galloway is slotted longitudinally and also faced off flat. The part of the crank pin thus cut away is replaced by a separate part, and the two parts are kept apart by a spring, so that on one of the diameters of the crank pin the hole which it enters is fitted by the pin. This construction, as I understand it, is for the purpose of avoiding chattering to a certain extent, but would not prevent the piston from freely taking the position which the steam forced it to take."

His conclusion, p. 193, is that "the piston of Galloway, which is like the appellees' and unlike the appellant's, had a practically free and uncontrolled movement, and therefore, if this claim be construed broadly enough to cover the appellees' device it must be construed broadly enough to cover Galloway, and therefore be bad for want of novelty."

The arrangement in the Galloway patent permits about the same amount of movement as is possible in the appellees' meter. Mr. Brevoort testifies (p. 71, Cross-Int. 216) that the only freedom and looseness of the piston of appellees' meter is that due to "the looseness of the fit of the piston in the case." This, obviously, would be a very small amount, because the shaft of the appellees' piston cannot pass the hub of the registering mechanism, and the play between the two is only a fraction of an inch. (Brevoort, p. 74, Cross-Int. 247.)

In his first deposition Mr. Brevoort contends that the Galloway engine has not a free and uncontrolled piston for the single reason that its freedom of motion is interfered with by the crank (p. 27, Cross-Int. 45), although he admits that the crank has a spring connection. Finding this view untenable, in his second deposition he takes the ground that the Galloway patent is not free and uncontrolled because of the fact that it "has to carry with it the cylinder head plate and move this plate over the valve surface, which is tantamount to imposing work upon the piston while it moves in its case, and thus the piston is not itself free but is called upon to perform work and move a separate and distinct part other than the piston." (Page 70, Cross-Int. 212.)

It is obvious that the presence of the head plate in the Galloway structure is merely equivalent to having a heavier piston. A little more weight added to the piston itself would interfere as much with its freedom of motion as the additional weight of the plate and the slight friction caused by its travel over the top of the case.

The Harford English patent here in evidence marked "Defendants' Exhibit Harford English Patent" shows the Galloway piston with the head plate cut off as in appellees' meter. (Brevoort, p. 70, Cross-Int. 213.)

Moreover, as has already been shown, the fourth claim now under consideration requires that the piston should have a free movement within the cylinder "controlled only by the shape of the cylinder, the shape of the piston and the *flow* of water through the meter."

Referring to the Nash specification, these requirements of the claim would seem to distinctly exclude any side pressure of the water as it flows through the meter, for the patent clearly comtemplates the absence of such side pressure. In the appellees' structure the flow which controls the motion of the piston is, as already shown, of an altogether different character, and a decided "side pressure" is distinctly necessary in order to make the meter operative. This side pressure is not caused by water flowing or the "flow of water." The water in these neutral chambers, which causes the side pressure, is not flowing at all, but is dead.

The fifth claim of appellant's reissue is like the fourth, except that it involves as an additional element that the piston should be of hard rubber. There is no basis in the specification for any such claim. The specification says that the piston may be of hard rubber or "other suitable material," so that in fact the fifth claim and the fourth which involves a piston, presumably of hard rubber or other suitable material, are precisely alike, and all that has been said with reference to the fourth claim applies to the fifth claim.

In so far as the use of hard rubber is concerned, it is an old and well-known substance for the manufacture of water meter pistons. It is described and claimed for that purpose in the Read patent here in evidence where its advantages are stated to be that it is lighter and more sensitive to the action of fluid and less likely to spring out of shape and be torn off by centrifugal force, and where it is also stated that the vulcanized rubber while very strong is "slightly elastic, so that if sprung out of form by any extraordinary force it will, when that pressure is removed, resume its original shape without breaking, as cast metal would not do." The Read patent also states that "vulcanized hard rubber is very light and strong. A propeller made of this material because of its lightness will revolve upon the slightest action of the passing fluid, and will thus indicate with the greatest accuracy."

These are the precise advantages involved in the use of hard rubber pistons in the appellant's and appellees' meters.

Mr. Brevoort's views as to the advantages involved in the use of

hard rubber are quite different in his two depositions (compare Brevoort, p. 18, Int. 7, and Brevoort, pp. 65, 66, Ints. 159–165).

Moreover, as appears from the deposition of Otis and Forsythe (pp. 201–211 of the record), hard rubber pistons had been in actual commercial use many years before Nash's invention in the well-known Union rotary meter which is illustrated in patent to Fitz No. 178,829 here in evidence.

This testimony is not controverted by the appellants. They simply undertake to show that certain advantages due to its well-known properties are involved in the use of hard rubber in the appellant's and appellees' meters, which are not present to the same extent in the Union and Read meters. They do not contend, however, that Nash discovered any new properties in hard rubber, or that it has any advantages in his or the appellees' meter, except such as are based on its special characteristics which had been known for years. The specification merely suggests the use of hard rubber, implying that every one would know why its use is desirable.

The distinctions which Mr. Brevoort undertakes to draw between hard rubber when used in the Union or Read meters and when used in the appellees' and appellant's meters are not well founded. As Mr. Tilden states, the selection of hard rubber for his piston is determined by considerations of cost (Tilden, p. 217, Cross-Int. 17). This is substantially admitted by Mr. Brevoort (p. 65, Cross-Ints. 163, 164).

As a matter of law we contend that the use of hard rubber, whose properties have been well known for years, would not be patentable even if it had never been used in a meter before. Mr. Renwick states (p. 192, Int. 15): —

"Vulcanite was a well-known substance many years prior to the date of the Nash patent, and it would not be a patentable invention to make a well-known piston, such as that shown in Kinematics, which is the plaintiff's piston, of this special well-known material, even though it was better than a metal piston, owing to the well-known properties of the material. But in addition to this, hard

rubber pistons were known to me more than twenty years ago, and have been applied to water meters as shown in the patent to Henry F. Read, dated in 1869 and reissued in 1871, and it appears to me that no valid patent could be granted for making one well-known kind of meter piston of hard rubber, when another well-known kind of meter piston had been previously made of hard rubber."

The following authorities are to the effect that the substitution of one well-known material for another does not involve patentable invention where, in the new use, advantage is taken only of the well-known properties of the material.

Hotchkiss v. *Greenwood*, 11 Howard, 248.
Hicks v. *Kelsey*, 11 Wallace, 670.

The sixth claim of appellant's reissue involves the structure of the first claim of the original patent "combined with ports controlled by said piston itself in its motion within said chamber." In the passage from his deposition already quoted (*supra*, pp. 40, 41), and also in his deposition (p. 181, Int. 6), Mr. Renwick describes clearly the features of construction to which this claim obviously relates.

Mr. Renwick testifies as follows with reference to this claim and the question of the relation of the appellees' structure to it (p. 193, Int. 15 of his deposition): —

"The sixth claim is to the same side-rocking piston and chamber of the plaintiff's which is not used by the defendants, when the receiving and discharging spaces into which the piston divides the cylinder communicate with ports controlled by said piston itself in its motion within the chamber. The defendants do not use the piston or the combination of chamber and piston described in the reissue. Neither do the defendants use 'ports in the ends of the piston communicating by means of passages in or through the piston with the spaces of the cylinder.' (See Nash reissue, lines 6–11, p. 2, which is the passage in the specification that this sixth claim most particularly refers to.) Neither do the defendants have ports or passages which open or close in similar order to those of the Nash reissue. The defendants do use ports or passages opened and controlled by the piston, but these ports are not revolving ports in the ends of the piston, like the plaintiff's but are stationary ports in the heads of the cylinder like those in the Ortlieb patent. In the plaintiff's contrivance the heads or ends of the cyclinder or case are the valves; in

the defendants' meter the piston itself is the valve as in the Ortlieb contrivance."

The appellants undertake to show that in the Ortlieb patent the ports are not controlled by the piston (Brevoort, p. 46, Int. 31). It is true that they are not controlled by the passage of the piston over them, but this also is true of the appellees' structure. (Brevoort, p. 66, Cross-Int. 173 and 174.) In the Ortlieb patent the ports are controlled by the slides (Brevoort, p. 68, Cross-Ints. 189–193), which occupy about the same relation to the ports as do the side walls of the appellees' piston which, as already shown, are quite sufficient to control the inlet. (See also Brevoort, pp. 66, 67, Cross-Ints. 176 and 179.)

THE NASH INVENTION NOT IN ANY SENSE A PIONEER.

The appellant contends that the claims of the Nash reissue are to be liberally construed because of the importance of his invention in view of the state of the art. There is no foundation for this contention. On the other hand, even on appellant's theory, the Nash invention resided merely in adapting one or both of the Galloway structures so as to make them useful as water meters, and merely by small modifications of those fundamental structures.

The appellees do not concede that the Nash structure relates at all to the Galloway 1846 patent, but it is clear that the Galloway 1843 patent, and the Kinematics article describing that structure, are the basis of Nash's meter. All that he has done is to introduce into that old structure a special and peculiar porting and a registering mechanism, neither of which in the nature of things could be broadly new or such inventions as to entitle him to the favorable rules of construction applied by the courts in dealing with inventions of a radical character.

On the contrary, it would seem that an infringer must have substantially the Nash structure to be held subject to his claims. This is particularly the case where, as in this instance, the appellee is *not charged with infringing a single claim of the original patent*, but only claims that were drawn after the Hersey meter was on the market, with the special view of bringing it within the scope of the reissue. In this effort, as already shown, the appellant can only succeed by

ignoring the structure and features of operation insisted upon by the specification as essential and by finding —

(*a*) That the single hole in the center of the Hersey piston, which is only a pipe, and has nothing to do with the porting, is the same as the complicated passages in the Nash piston which are essential to his porting (claim 3);

(*b*) By finding that the loose connection between the piston and the crank of the registering mechanism (old in the Galloway 1846 patent) was a substantial invention when used by Nash for one purpose, so that his claim for it covers the appellee's structure where this old Galloway connection is used for another purpose in a combination not at all the same as Nash's and not having the same controlling means that are emphasized by him (claims 4 and 5);

(*c*) By finding that the use of hard rubber (an old and well-known material for water-meter pistons) instead of metal as in Galloway's, gives patentable novelty to the structure, although Nash himself only "prefers" it (claim 5); and by finding that the "ports in the ends of the piston communicating by means of passages in or through the piston with the spaces of the cylinder" required by the specification are found in the Hersey meter, which has no such ports or passages, and which controls the inflow and outflow of the water by entirely different means borrowed from the Galloway 1846 patent (claim 6).

If any of these inventions were radical departures in the art, a different question might arise. Under the conditions characterizing this case, the true construction of the claims must exclude the appellees' meter, even if they are wrong on the main contention that their meter does not have the structure and mode of operation described in the first claim of the original patent which appears bodily in all the claims relied on.

The fact that this Nash structure may be better as a water meter than the structures on which it is based is immaterial. The reissue admits that the substantial features of the invention are old, and is in terms for pumps and engines as well as water meters.

It is respectfully submitted that if the appellees' meter involved the subject matter of the first claim of the Nash original patent, which is not the fact, it would not embody those additional features

of construction which are interpolated in the third, fourth, fifth and sixth claims of the reissue, and that therefore it cannot be regarded as an infringement of those claims.

Invalidity of Appellant's Reissue.

The theory upon which the appellant seeks to justify its procurement of the reissue in suit is wholly untenable, both in fact and in law.

First, it is not true, as the appellant contends, that the first claim of Nash's original patent embraced within its terms, or as the equivalent of the structure therein specified, such a combination of piston and cylinder-chamber as was described and shown in the prior English patent of Elijah Galloway, dated Dec. 14, 1846, and numbered 11,485.

Second, if the first claim of Nash's original patent could properly and legally be construed, as the appellant now contends it should be, so as to embrace within its terms, or as the equivalent of the structure therein specified, the combination of piston and cylinder chamber described and shown in Galloway's said prior English patent, even then there would be no legal warrant for the reissue in suit with claims embracing new combinations which were not described or suggested in the original patent as subject matter of invention intended to be patented therein, which is the necessary construction to be given those claims on the theory of appellant.

Each of these points and the law applicable thereto will now be discussed.

First Claim of Nash's Original Patent. The first claim of original patent No. 211,582, granted to Lewis H. Nash, Jan. 21, 1879, is as follows: —

"A piston for water meters, pumps and motors having alternate bearing points, or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points, or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber, to effect its division at two or more points on its sides, into receiving and discharging spaces, *c c*, which communicate with the inlet and outlet."

Upon this claim and its signification rests the whole of appellant's case.

The contention of the appellant is, that it embraces in its terms more than is specifically described in the specification and shown in the drawings, that is, the structure of the Galloway 1846 patent and the appellees' meter; but the law is clearly otherwise.

In the first place, the nature and scope of a patented invention are ascertained and determined by the definitive terms of the claim itself. Those terms may be qualified or limited by descriptions and explanations contained in the body of the specification, and by restrictions of the field of invention, imposed by the prior state of the art; but, however much the terms of a claim may thus be qualified or limited, their explicit meaning can never be transcended or expanded.

In the case of *Keystone Bridge Company* vs. *Phenix Iron Company* (95 U. S. 274, 278, 279), the Supreme Court of the United States, speaking by Mr. JUSTICE BRADLEY, said: —

"But the courts have no right to enlarge a patent beyond the scope of its claim as allowed by the Patent Office, or the appellate tribunal to which contested applications are referred. When the terms of a claim in a patent are clear and distinct (as they always should be), the patentee, in a suit brought upon the patent, is bound by it. *Merrill* v. *Yeomans*, 94 U. S. 568. He can claim nothing beyond it. But the defendant may at all times, under proper pleadings, resort to prior use and the general history of the art to assail the validity of a patent or to restrain its construction. The door is then opened to the plaintiff to resort to the same kind of evidence in rebuttal; but he can never go beyond his claim. As patents are procured *ex parte*, the public is not bound by them, but the patentees are. And the latter cannot show that their invention is broader than the terms of their claim; or, if broader, they must be held to have surrendered the surplus to the public."

Again, in the case of *Burns* vs. *Meyer* (100 U. S. 671, 672), the same court, speaking by the same justice, said: —

"It is well known that the terms of the claim in Letters Patent are carefully scrutinized in the Patent Office. Over this part of the specification the chief contest generally arises. It defines what the Office, after a full examination of previous inventions and the state of the art, determines the applicant is entitled to. The courts, there-

fore, should be careful not to enlarge, by construction, the claim which the Patent Office has admitted, and which the patentee has acquiesced in, beyond the fair interpretation of its terms."

In the latter case of *Railroad Company* vs. *Mellon* (104 U. S. 112, 118, 119), the same court, speaking by Mr. JUSTICE WOODS, emphasized the rule that the explicit language of a claim cannot be transcended, as follows: —

"We are, therefore, justified in looking at the claim with which the specification of the appellee's invention concludes, to determine what is covered by his Letters Patent.

The claim, so far from covering an angular flange upon the wheel expressly excludes such a flange, and embraces only a flange with a curved or rounded corner.

In this case the description of the appellee's invention is much broader than his claim. It seems quite clear from the present form of his specification, and from the fact that his application for a patent was twice rejected, that he was compelled by the Patent Office to narrow his claim to its present limits before the commissioner would grant him a patent. In doing this he neglected to amend the descriptive part of his specification. He cannot go beyond what he has claimed and insist that his patent covers something not claimed merely because it is to be found in the descriptive part of the specification.

The appellee is, therefore, precluded from claiming relief against the appellant for the use of a flange with a square corner."

Later still, in the case of *White* vs. *Dunbar* (119 U. S. 47, 51, 52), Mr. JUSTICE BRADLEY, delivering the opinion of the court, said: —

"Some persons seem to suppose that a claim in a patent is like a nose of wax which may be turned and twisted in any direction, by merely referring to the specification, so as to make it include something more than, or something different from, what its words express. The context may, undoubtedly, be resorted to, and often is resorted to, for the purpose of better understanding the meaning of the claim, but not for the purpose of changing it, and making it different from what it is. The claim is a statutory requirement, prescribed for the very purpose of making the patentee define precisely what his invention is; and it is unjust to the public, as well as an evasion of the law, to construe it in a manner different from the plain import of its terms. This has

been so often expressed in the opinions of this court that it is unnecessary to pursue the subject further."

The same principle is emphatically laid down by the Supreme Court in the recent case of *McClain* vs. *Ortmayer*, 141 U. S. 419, 423, where the Supreme Court held that a claim must be limited so that the defendant did not infringe it, although it was intimated that the patentee might well have made a broader claim.

The opinion of the court, by Mr. Justice Brown, lays down the law in the following language: —

"It is evident from this patent and from the entire testimony that the defendants made use of a single hook D, embracing the front roll of the collar only, while the appellant McClain has limited himself, perhaps unnecessarily, to the elastic springs *s s*, which the drawings and the whole tenor of the specification show to be double and intended to be clasped around both the fore and after wales of the collar. While the patentee may have been unfortunate in the language he has chosen to express his actual invention, and may have been entitled to a broader claim, we are not at liberty, without running counter to the entire current of authority in this court, to construe such claims to include more than their language fairly imports. Nothing is better settled in the law of patents than that the patentee may claim the whole or only a part of his invention, and that if he only describe and claim a part, he is presumed to have abandoned the residue to the public. The object of the patent law in requiring the patentee to 'particularly point out and distinctly claim the part, improvement or combination which he claims as his invention or discovery,' is not only to secure to him all to which he is entitled, but to apprise the public of what is still open to them. The claim is the measure of his right to relief, and while the specification may be referred to to limit the claim, it can never be made available to expand it."

The Court then refers to numerous previous decisions to this effect, and then continues: —

"It is true that, in a case of doubt, where the claim is fairly susceptible of two constructions, that one will be adopted which will preserve to the patentee his actual invention; but if the language of the specification and claim shows clearly what he desired to secure as a monopoly, nothing can be held to be an infringement which does not fall within the terms the patentee has himself chosen to express his invention. The principle announced by this court in

Vance vs. *Campbell*, 1 Black, 427, that, where a patentee declares upon a combination of elements which he asserts constitute the novelty of his invention, he cannot in his proofs abandon a part of such combination and maintain his claim to the rest, is applicable to a case of this kind where a patentee has claimed more than is necessary to the successful working of his device."

Other cases in which the same doctrine has been illustrated and applied are the following: —

Eddy vs. *Dennis*, 95 U. S. 560, 565, 566.

Werner vs. *King*, 96 U. S. 218, 229, 231.

Schumacher vs. *Cornell*, 96 U. S. 549, 553–556.

Water Meter Co. vs. *Desper*, 101 U. S. 332, 336.

Hoffheins vs. *Russell*, 107 U. S. 132, 142.

Fay vs. *Cordesman*, 109 U. S. 408, 420, 421.

Bussey vs. *Excelsior Mfg. Co.*, 110 U. S. 131, 137.

Zane vs. *Soffe*, 110 U. S. 200, 204.

McMurray vs. *Mallory*, 111 U. S. 97, 104.

Turner & Seymour Co. vs. *Dover Stamping Co.*, 111 U. S. 319, 325.

Rowell vs. *Lindsay*, 113 U. S. 97, 101, 103

Blake vs. *San Francisco*, 113 U. S. 679, 681.

Sargent vs. *Hall Safe & Lock Co.*, 114 U. S. 63, 85, 86.

Electric Signal Co. vs. *Hall Signal Co.*, 114 U. S. 87, 96, 103.

Clark vs. *Beecher Mfg. Co.*, 115 U. S. 79, 86, 87.

Wollensak vs. *Reiher*, 115 U. S. 87, 94.

Field vs. *DeComeau*, 116 U. S. 187, 190.

Brown vs. *Davis*, 116 U. S. 237, 249.

Shepard vs. *Carrigan*, 116 U. S. 593, 595, 597.

Yale Lock Co. vs. *Sargent*, 117 U. S. 373, 377, 378.

Newton vs. *Furst & Bradley Co.*, 119 U. S. 373, 383, 384.

Sharp vs. *Riessner*, 119 U. S. 631, 636.

Snow vs. *Lake Shore &c. R. R. Co.*, 121 U. S. 617, 629, 630.

Dryfoos vs. *Wiese*, 124 U. S. 32, 36, 37, 38.

Matthews vs. *Iron Clad Mfg. Co.*, 124 U. S. 347, 350.

Wier vs. *Morden*, 125 U. S. 98, 106, 107.

Hendy vs. *Miners Iron Works*, 127 U. S. 370, 375.

Crescent Brewing Co. vs. *Gottfried*, 128 U. S. 158, 170.
Day vs. *Fairhaven Railroad Co.*, 132 U. S. 98, 102.
Haines vs. *McLaughlin*, 135 U. S. 584, 596.

An examination of the case of *Hoyt* vs. *Horne*, 145 U. S. 302, shows that in that case there was no departure from the principles of law for which we contend. The patented machine was a pulp engine in which the operative mechanism consisted of a beater roll set with knives and a bed plate also set with knives, between which the pulp was to pass repeatedly for the purpose of grinding it. The mechanism was enclosed in a tank and it was necessary that the pulp should be circulated in this tank to bring it repeatedly between the roll and the bed plate. In prior machines the material had been circulated in a horizontal plane around an upright partition in the tank, on one side of which was the beater roll and bed plate. The only "head" which the material had to aid it in its circulation was secured by the revolution of the roll, in the same direction with the flow of the pulp, which lifted the material up over the dam at the back of the bed plate, thus securing a slight fall solely by the action of gravity.

The patentee placed the beater roll at the end of the tub and lifted the material, after it had passed between the beater roll and the bed plate, up over the beater roll, delivering it with great velocity into the upper section of the vat which was separated from the lower section by a horizontal partition. By this arrangement the centrifugal action of the roll, combined with the height to which the pulp was lifted, resulted in the far more vigorous circulation. This was a great improvement in the art. The substantial feature of the invention was this arrangement of beater roll at the end of the tub and its action in delivering the pulp violently at the upper section of the vat.

The first claim was as follows: —

"The improvement in beating rags to pulp in a rag engine having a beater roll and bed-plate knives, consisting in circulating the fibrous material and liquid in vertical planes, drawing the same between the knives at the bottom of the vat, carrying it around and over the roll and delivering it into the upper section of the vat, substantially as described."

In the defendant's machine, the beater roll was arranged exactly as was that of the plaintiff's patent and operated in all respects as did the roll of the plaintiff's patent. At that end of the machine, the circulation of the pulp was "in vertical planes," and it was therefore "delivered into the upper section of the vat." The difference was that as soon as the material had left the roll in the defendant's machine, it circulated in a path like that of a twisted belt around a vertical partition instead of continuing its circulation in vertical planes as was the case with the complainant's machine.

The Court held that "the circulation of the material around the roll in vertical planes was the salient feature of the Hoyt invention," and that the defendant had employed this feature and therefore infringed the patent because the substitution of a vertical for a horizontal midfeather at the inoperative end of the tub, was not a difference in the substance of the invention, but was the employment of an old and well-known mechanical equivalent for that subsidiary portion of the complainant's structure. It is significant, however, that in this case the Court declined to hold that the defendant's machine infringed the second claim of the Hoyt patent which is as follows: —

"A rag engine for paper making, comprising the vat, the beater roll mounted on a horizontal shaft in one end of the vat, and the horizontal partition dividing the body of the vat into an upper and a lower section or passage, the fibrous material and liquid being carried from the lower section between the knives and delivered over the top of the beater roll into the upper section or passage, substantially as described."

The Court suggested, with reference to this claim, that the limitations of the claim itself were such as to make the question of infringement a very troublesome and difficult one with which the Court declined to deal.

The substance of this decision, therefore, is that giving to the language of the first claim of the Hoyt patent a fair and reasonable interpretation, the defendant's machine was within its scope, for those portions of the two machines which differed, namely, the precise arrangement of the paths to be followed by the pulp at a

point away from the roll, were not sufficient to remove from the scope of the claim a machine which had the "circulation in vertical planes" and delivered the pulp "into the upper section of the vat" in all substantial particulars.

Manifestly, therefore, the first claim of the original patent to Nash here under consideration calls explicitly for a piston and cylinder chamber of such construction that the piston shall "have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber"; and further that this construction and mode of operation shall be such as to effect the division of the cylinder chamber "at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet." As already pointed out, the "rotary" motion of the piston is necessarily involved in its "side-rockings."

And this means, under the explanations contained in the body of the specification, (1) that the piston has at least one projection less than the cylinder; (2) that the piston divides the cylinder into separate receiving and discharging spaces by contact of one of its projections with a recess of the cylinder, or conversely, and by another contact on the opposite side of both piston and cylinder between two projections, one on each; (3) that the piston rocks sidewise across the centre of the cylinder upon successive bearing surfaces made by the contact of a projection upon the piston with a recess of the cylinder or of a recess on the piston with a projection upon the cylinder; and (4) that the piston by virtue of such side-rocking motions also progressively accomplishes a rotation upon its own axis.

The contention of the appellant is that this first claim of Nash's original patent embraces in its scope, not only the structure specifically described in the specification, but also as an equivalent structure the piston and cylinder chamber of Galloway's English patent of Dec. 14, 1846, which although not so organized as to permit the piston to have the side-rocking movement of the pistons described

and shown in Nash's patent, yet, nevertheless, involves a movement of the piston which may be called "eccentric."

The further contention of the appellant is that the first claim of Nash's original patent by the expression "to have an eccentric or side-rocking movement," signifies that the piston of the structure therein referred to is to have *either* the eccentric movement which is the side-rocking movement described in the specification *or* the eccentric movement exemplified by the structure described in Galloway's English patent of 1846, which is alleged to be an equivalent of the structure described in Nash's original patent and referred to in the first claim thereof, although the piston of this Galloway structure does not have any side-rocking movement.

But such contention on the part of appellant is wholly untenable and without any legal support.

In every question of equivalency arising under the patent law, one of the terms of comparison must always be the subject matter or a constituent part of the subject matter of some claim in a patent.

Hence it is an essential prerequisite to the solution of such a question that the legal meaning of the claim involved should be determined.

To raise the question of equivalency in the present case it is primarily necessary to determine what is the particular subject matter of invention embraced in the first claim of Nash's original patent; and if it be true that the piston therein specified is characterized by an eccentric movement which is also a side-rocking movement, or which is, at least, accompanied by and consequent upon a side-rocking movement; then there can be no equivalent for the piston of this claim which has not likewise substantially the same side-rocking movement.

Again, if it be true that the receiving and discharging spaces *c c* specifically mentioned in this claim are located upon opposite sides of the piston and cylinder chamber, and result from a division of the cylinder chamber by the piston, in the manner described in the specification of the patent, that is to say, by the contact of a pro-

jection upon the piston with a recess of the cylinder or conversely, and by another contact on the opposite side of both piston and cylinder between two projections, one on each; then there can be no equivalents of these receiving and discharging spaces *c c*, which do not have substantially the same relationship to a piston and cylinder constructed and operating in substantially the same way.

This rule of law is well illustrated by a decision of the Supreme Court relating to a patented invention which consisted in the employment of certain eccentric rollers in a combination lock to disconcert the action of the interior mechanism so as to prevent a burglar from ascertaining the position of the rotary tumblers by means of a micrometer applied to the spindle outside.

The specification of the patent in that case stated: —

"The invention consists in combining with the cam an arrangement of two or more eccentric rollers, of varying eccentricity, turning upon the same bearing, so that in revolving one or both may turn and alternate in action, thereby greatly increasing the difficulty of mapping out or locating the position of either."

And the claim was as follows: —

"The arrangement of two or more rollers, H, H′, of varying eccentricity, when combined with the cam, in the manner and for the purpose specified."

The defendant used two disconcerting rollers of the same eccentricity in combination with a cam for the same purpose; and Mr. Justice Matthews delivering the opinion of the court upon the issues raised, said: —

"If therefore, a variation of eccentricity in the rollers is a material feature of the invention, or is made material by the description and claim of the patent, no infringement has been proved.

"It does not meet and answer the difficulty to say, as has been suggested in argument, that although the rollers in the defendant's locks may be of the same eccentricity and shape as respects each other, yet that, when in revolution, they vary in eccentricity in reference to the cam which operates them, so that in action their eccentricity varies, and the same result is produced; because the description in the patent and the claim require that the variation of eccentricity should be between the rollers themselves, and not a

variation in action in reference to the cam, and unless the same result is produced by the same means, there is no infringement of the invention. Besides, the fact is not as claimed. It is impossible, mechanically, for the rollers, being identical in eccentricity and shape with each other, to have the same relation at all times to the cam as though they varied in eccentricity. For, as is pointed out in the evidence on the part of the defendant, when the rollers are the same in eccentricity and shape with each other, there must be intervals of time at which 'the two rollers, having been rotated to a point at which their peripheries exactly coincided, both would revolve together for a short period, until some slight impediment or change in the periphery of the cam would cause one to bear more directly than the other upon the periphery of the cam, when this one would revolve with the cam, the other remaining stationary, and so on.' And this feature in the action of two rollers, identical in eccentricity, it is said, introduces an additional irregularity into the operation of the mechanism, which increases its disconcerting power, and adds to the difficulty of calculating the movement which enables the expert to pick the lock. So that the mode of operation is different accordingly as the rollers are of the same or varying eccentricities.

"Were it otherwise, however, it would still be necessary to regard the feature of a variation of eccentricity as essential to the invention, because made so by the description and claim of the patent, although an equally good or even the same result might be obtained without it. The defendant does not use the same combination, and employs no device as an equivalent and substitute for the omitted element. It is not, therefore, liable as an infringer."

Yale Lock Co. vs. *Sargent*, 117 U. S. 373, 377, 378.

From this it will be seen that even if the defendant's rollers from a mechanical standpoint had been proved to be equivalent in mode of operation and result to the rollers of the patented mechanism, nevertheless the question of equivalency from a legal standpoint was confined to the features which the claim itself made essential to the invention embraced therein.

Variation of eccentricity was by the terms of the patent itself made a material feature of the invention claimed, and it admitted of no equivalency in rollers which were not of varying eccentricity.

Doubtless the real invention of the patentee was actually broader than what he had described and claimed it to be; and if his description and claim had been different, they might have admitted a correspondingly different application of the doctrine of equivalents; but the thing claimed constituted one term of the comparison, and its

equivalent must necessarily possess the characteristics which the claim specifies as essential to it.

Equivalency in the patent law is predicated only with reference to the subject matter of a legally construed claim and never with reference to what might be ascertained to be the invention of the patentee in view of the prior state of the art, and independently of the limitations of the formal claim in his patent when properly construed.

Further illustrations of this rule will be found in the following cases decided by the Supreme Court.

A claim which called for "wide and thin rolled bars with enlarged ends" in the chords of truss bridges, did not embrace as equivalents cylindrical bars flattened only at the ends.

Keystone Bridge Co. vs. *Phœnix Iron Co.*, 95 U. S. 274, 275–279.

A claim to a combination in a shovel plough, wherein one of the elements was "the adjustable wheel F" which served as a fulcrum on which the plow could be tilted, was held not to cover as an equivalent a sliding heel which was neither a wheel nor adjustable.

Eddy vs. *Dennis*, 95 U. S. 560, 565, 566.

A claim for "the guide E constructed with one or more curved or arched portions a'" for the purpose of producing a redundant fulness in the central portions of cloth which passed thence to fluting rollers, was held not to cover, as an equivalent, a flat guide with a retarding detent bearing thereon, which produced a similar effect upon the cloth.

Werner vs. *King*, 96 U. S. 218, 229–231.

See also

Schumacher vs. *Cornell*, 96 U. S. 549, 553–556.
Water Meter Co. vs. *Desper*, 101 U. S. 332, 336.
Railroad Co. vs. *Mellon*, 104 U. S. 112, 118, 119.
Fay vs. *Cordesman*, 109 U. S. 408, 414.
McMurray vs. *Mallory*, 111 U. S. 97, 104.
Rowell vs. *Lindsay*, 113 U. S. 97, 101, 103.
Blake vs. *San Francisco*, 113 U. S. 679, 681.

Sargent vs. *Hall Safe & Lock Co.*, 114 U. S. 63, 85, 86.
Electric Signal Co. vs. *Hall Signal Co.*, 114 U. S. 87, 96, 103.
Field vs. *De Comeau*, 116 U. S. 187, 190.
Brown vs. *Davis*, 116 U. S. 237, 249.
Newton vs. *Furst & Bradley Co.*, 119 U. S. 373, 383, 384.
Sharp vs. *Riessner*, 119 U. S. 631, 636.
Crawford vs. *Heysinger*, 123 U. S. 589, 606, 607.

Each of the foregoing cases is instructive upon the point here under consideration; but the following more recent case is especially pertinent.

The patent related to a gang-needle sewing machine with a progressively increasing feed from one end of the gang of needles to the other end, so as to enable the machine to sew or quilt skirts or frusto-conical garments with symmetrical lines of stitching.

The claim there in controversy was as follows: —

"The combination with a series of vertically reciprocating needles mounted in a laterally reciprocating sewing frame, of conical feed rolls and mechanism for causing them to act intermittingly during the intervals between the formation of stitches, substantially as herein shown and described."

The defendant, instead of using "conical feed rolls" thus specified in the claim, employed in his gang-needle sewing machines short cylindrical feed-rollers moving at different rates of speed to effect a forward movement of the cloth corresponding to its increasing circular dimensions; and in another machine the defendant employed the well-known four-motion feed with progressively lengthened movement from the shortest to the longest edge of the goods.

Mr. Justice Blatchford, delivering the opinion of the court, said: —

"It is contended for the plaintiff, that, as Beck was the first to devise a combination the gist of which is a feed feeding faster at one end than at the other, with a laterally moving gang or series of needles, and an intermittent feed when the needles are out of the stitches, he is entitled to cover all variations in the form of the feed, so long as by any means it operates to feed faster at one end than at the other; and that, if that result is accomplished, the mechanism must be an equivalent for that of the plaintiff.

"The plaintiff's patent must be limited to the mechanism described and claimed by him, and cannot be extended so as to cover all mechanism for giving a circular direction to the feed motion, nor to the process of operation of the mechanism described in his patent; and the defendant's mechanism, in each form of his machine, cannot be regarded as merely an equivalent for the plaintiff's mechanism. The case is substantially like that of *Yale Lock Company* vs. *Sargent*, 117 U. S. 373."

Dryfoos vs. *Wiese*, 124 U. S. 32, 37, 38.

It can hardly be doubted that the real invention of this patentee was much broader than the subject matter of his claim; and that if he had adequately described and claimed it in his patent the defendant's machines might have been held to contain the equivalents of the specific structure in which he had embodied it.

But, however this may have been, it is certain that under the patent law no question of equivalency can arise which does not take into account the features which, by the terms of a claim in a patent when properly and legally construed, are made essential characteristics of the subject matter of invention claimed.

In the case at bar, therefore, it was not possible for any prior water meter, pump or motor to contain the equivalent of the subject matter of the first claim of Nash's original patent unless it possessed all the features set forth and referred to in that claim as characterizing the piston and cylinder chamber and the receiving and discharging spaces *c c* therein specified.

There is no pretence on the part of the appellant that the motor described and shown in Galloway's English patent of 1846 contained a piston which divided the cylinder into separate receiving and discharging spaces on opposite sides of both; nor a piston which effected such division by contact of one of its projections with a recess of the cylinder or conversely, and by another contact on the opposite side of both piston and cylinder between two projections, one on each; nor a piston which by virtue of its side-rocking movements progressively accomplished a rotation upon its own axis.

The only ground upon which the appellant bases its contention

that the prior Galloway structure did contain the equivalent of the subject matter of the first claim of Nash's original patent is that this claim calls for "an eccentric or side-rocking movement" of the piston, and that the movement of the piston in Galloway's motor is in a path eccentric to the case.

Such contention ignores the fact that even if the term "side-rocking" were eliminated from the claim upon the assumption that it was not a synonym of the term "eccentric" as used in this patent, the claim thus altered would still call for such a construction and adaptation of piston and cylinder chamber that the piston would have "an eccentric movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*"; and this would necessitate just such a structure as is described in the body of the specification, wherein the piston necessarily must have a side-rocking movement and a rotation upon its own axis, and must divide the cylinder chamber into receiving and discharging spaces *c c* located upon opposite sides of both piston and cylinder.

There is no stretch of interpretation permissible in the law which can possibly bring the structure of the Galloway motor within the scope of this first claim of Nash's original patent. Even if the language of the claim itself were less specific than it is, its meaning would be controlled by the description and explanatory portions of the specification, and would leave no chance for giving any different signification to the term "eccentric" than to the term "side-rocking."

Whatever may be the meaning of which the word "eccentric" is capable in other connections, it cannot, in the specification and claims of Nash's original patent, denote or connote anything else than the character of the movement of the piston described in that specification; nor can it signify any less than the whole of the movement from which the characteristic of eccentricity results, namely, the side-rocking movement which is described and illustrated with superfluous iteration. No other eccentric movement of the piston than this side-rocking movement is described, shown, indicated or suggested anywhere in this patent; and no warrant can be found

either in the law or in ordinary good sense for attributing to the term "eccentric," as used in this patent, any meaning which divorces it from the signification of "side-rocking."

The rule that language of general designation in a claim is to be interpreted by reference to the description in the specification of the thing so designated and is to be limited in its signification by the distinguishing characteristics of the thing so referred to and described, will be found exemplified in the following cases: —

Cammeyer vs. *Newton*, 94 U. S. 225, 236–238.
Schumacher vs. *Cornell*, 96 U. S. 549, 553–556.
Wicke vs. *Ostrum*, 103 U. S. 461, 470.
Bridge vs. *Excelsior Co.*, 105 U. S. 618, 619.
Voss vs. *Fisher*, 113 U. S. 213, 214, 215.
Sargent vs. *Hall Safe & Lock Co.*, 114 U. S. 63, 85, 86.
Clark vs. *Beecher Mfg. Co.*, 115 U. S. 79, 86, 87.
Grier vs. *Wilt*, 120 U. S. 412, 429, 430.
Snow vs. *Lake Shore Railroad Co.*, 121 U. S. 617.
Crawford vs. *Heysinger*, 123 U. S. 589, 606, 607.
Joyce vs. *Chillicothe Foundry*, 127 U. S. 557, 562.
Consolidated Roller Mill Co. vs. *Walker*, 138 U. S. 124, 132.

Furthermore, the designation of the receiving and discharging spaces mentioned in this claim by the letters of reference *c c* make it impossible that the features of the structure so referred to should be anything else than those which characterize the division of the cylinder chamber by the piston, by contact of a projection and recess upon one side and of two projections upon the opposite side, and which thus involve the whole peculiar construction and mode of operation of the piston and cylinder described and shown in the specification and drawings of this patent.

The rule that designation of mechanical elements in a claim by letters of reference to the drawings makes the features of the elements so designated essential characteristics of the structure or device so referred to, has constantly been acted upon by the courts and is exemplified in the following cases:

Water Meter Co. vs. *Desper*, 101 U. S. 332, 336.
Zane vs. *Soffe*, 110 U. S. 200, 204.
McMurray vs. *Mallory*, 111 U. S. 97, 104.
Turner & Seymour Co. vs. *Dover Stamping Co.*, 111 U. S. 319, 325, 326.
Rowell vs. *Lindsay*, 113 U. S. 97, 101, 103.
Blake vs. *San Francisco*, 113 U. S. 679, 681.
Electric Signal Co. vs. *Hall Signal Co.*, 114 U. S. 87, 96, 103.
Field vs. *De Cormeau*, 116 U. S. 187, 190.
Yale Lock Co. vs. *Sargent*, 117 U. S. 373, 377, 378.
Newton vs. *Furst & Bradley Co.*, 119 U. S. 373, 383, 384.
Sharp vs. *Riessner*, 119 U. S. 631, 636.
Snow vs. *Lake Shore &c. R. R. Co.*, 121 U. S. 617, 629, 630.
Matthews vs. *Iron Clad Mfg. Co.*, 124 U. S. 347.
Weir vs. *Morden*, 125 U. S. 98, 106, 107.
Hendy vs. *Miners' Iron Works*, 127 U. S. 370, 375.

Nor does the fact that in other claims the same limitations are expressed as entering into the subject matter of invention there specified, furnish any sufficient reason why such limitations should not be implied in a claim which does not explicitly mention them.

Fay vs. *Cordesman*, 109 U. S. 408, 420, 421.
Clements vs. *Odorless Apparatus Co.*, 109 U. S. 641, 647, 649.
Crawford vs. *Heysinger*, 123 U. S. 589, 606, 607.
Weir vs. *Morden*, 125 U. S. 98, 106, 107.

Hence the more specific description of the construction and mode of operation of the piston and cylinder chamber set forth in the second claim of Nash's original patent cannot affect the interpretation of the less specific language of the first claim.

We confidently submit, therefore, that the first claim of Nash's original patent did not and could not have the signification which the appellant has sought to attribute to it, and furnished no lawful reason for the procurement of the reissue here in suit, which will now be considered.

The Reissue in Suit. The specification of the reissued patent here in suit down to the first paragraph, which constitutes a disclaimer immediately preceding the claims, is in precisely the same language as the specification of Nash's original patent preceding its claims.

Hence, leaving out of account the disclaimer and new claims which have been added to the reissue, the structures described in both patents are the same.

Furthermore, the 7th, 8th, 9th, 10th, 11th, 12th and 13th claims of the reissue are the same as the 2d, 3d, 4th, 5th, 6th, 7th and 8th claims, respectively, of the original patent while the first claim of the original patent has been disclaimed; so that the 1st, 2d, 3d, 4th, 5th and 6th claims of the reissue, together with the paragraph immediately preceding them and containing the disclaimer, constitute all the new matter which has been introduced therein, as compared with the original patent.

The disclaimer which has been interpolated into this reissue is in the exact language of the first claim of the original patent, and is followed by an explanation obviously intended to give to the language of that claim an interpretation which it was never intended to have, and of which it is not capable.

The disclaimer is as follows (sub-quotation marks being added to indicate the language of the first claim of the original patent): —

> "I do not claim broadly
>
> 'A piston for water meters, pumps and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c* which communicate with the inlet and outlet,
>
> as a motor having a piston of substantially such construction and movement within a cylinder chamber having such construction is shown and described in the English patent of Elijah Galloway, December 14, 1846, No. 11,485; but what I do claim are said elements in combination with additional elements as hereinafter

specified, thereby limiting my claims to the novel features embraced in my meter."

The real motive for this disclaimer is at once apparent as soon as the prior English patent to Galloway referred to is examined and the structure described and shown therein compared with the subject matter of the first claim of the original patent to Nash upon which the reissue in suit is founded.

That motive is manifestly to enlarge the scope of the reissue by attempting to give an unwarrantably broad construction to the first claim of the original patent and then under the guise of a disclaimer to make it the principal part of new claims in which, notwithstanding certain pretended limitations by the addition of other elements to the several combinations specified, it is to be given the same broad interpretation.

But the fact is that the subject matter of the first claim of the original patent to Nash was not embraced in the structure described and shown in the prior English patent to Galloway; and that no claim in Nash's original patent could be legally or properly so construed as to be anticipated by anything set forth in Galloway's English patent.

The only piston described and shown in Nash's original patent was one having the following essential features, no one of which was embraced in the structure patented to Galloway.

That is to say: —

(1.) Nash's piston has, at least, one less projection and one less recess than the cylinder in which it works; while Galloway's piston has just as many projections and recesses as its cylinder.

(2.) Nash's piston divides the cylinder into separate receiving and discharging spaces by contact of one of its projections with a recess of the cylinder or conversely, and by another contact on the opposite side of both piston and cylinder between projections on each; while Galloway's piston upon one side of it only divides the separate recesses of the cylinder into receiving and discharging spaces by contact of projections upon the piston with recesses in the

cylinder and of projections upon the cylinder with recesses in the piston, all on the same side of both.

(3.) Nash's piston rocks sidewise across the centre of the cylinder upon successive bearing surfaces made by the contact of a projection on the piston with a recess in the cylinder, or of a recess in the piston with a projection upon the cylinder; while Galloway's piston does not rock at all.

(4.) Nash's piston by virtue of its successive side-rocking motions also progressively accomplishes a rotation upon its own axis; while Galloway's piston does not rotate at all.

Indeed, as has already been shown by examination and analysis of all the descriptive language contained in the specification of the original patent to Nash and appertaining to the piston and cylinder, no form of construction or mode of operation of these two parts of the structure is suggested or indicated which is not characterized by each of the four peculiarities hereinabove enumerated as the essential features thereof and as in nowise embraced by the structure described and shown in Galloway's English patent.

The first claim of Nash's original patent, which the reissue in terms disclaims, calls for a piston "having alternate bearing points or projections and recesses *adapted*, by means of a cylinder chamber having alternate bearing points or projections and recesses, *to have an eccentric or side-rocking movement* within and upon continually changing lines across the centre of said chamber."

The only adaption which the piston in co-operation with the cylinder has for an eccentric or side-rocking movement is its construction with at least one less projection and recess than the cylinder possesses, and the only eccentric or side-rocking movement which the piston has is that accomplished by a bearing between a projection upon the piston and a recess in the cylinder or conversely in such manner as to allow a projection upon the opposite side of the piston to pass by and in contact with an opposed projection upon the cylinder; and thus by such bearing of a projection within a recess at one side and such contact of projections at the other side to enable the piston to divide the cylinder substantially diametri-

cally, or in the language of the first claim of the original patent, "to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet."

These receiving and discharging spaces *c c* are described in the specification and represented in the drawings as always upon opposite sides of the division formed by the bearing contact upon which the piston rocks, and the passing contact which a projection upon the opposite side of the piston makes with an opposed projection on the cylinder; and such receiving and discharging spaces *c c* result directly from the eccentric or side-rocking movement of the piston upon continually changing bearing points; and this movement involves the rotation of the piston upon its own axis; while the whole mode of operation depends upon the fact that the piston has at least one less projection and recess than the cylinder.

All this is fully set forth in the specification of Nash's original patent and clearly defines the meaning of the terms employed in the first claim thereof.

There is in that original patent no description, suggestion or indication that the eccentric movement of the piston therein mentioned and referred to is not one and the same thing as what is also therein called its side-rocking movement; nor is there in that original patent any description, suggestion or indication of any eccentric or side-rocking movement of the piston which does not also involve the rotation of the piston upon its own axis.

It is therefore unquestionably evident that the object of the disclaimer introduced into the appellant's reissue is to give a false interpretation to the language of the first claim of the original patent, in order to disguise the fact that the invention specified in each of the new claims of the reissue is altogether different from what was intended to be secured by the original patent and has a greatly enlarged scope notwithstanding the seeming limitations imposed by the addition of other elements to the combination specified.

These limitations are in fact so vague and general in their terms that they constitute no substantial restriction upon the broad invention which the disclaimer attempts to ascribe to the language of the first claim of the original patent, and which under such attempted interpretation is introduced into the new claims of the reissue by the very same language.

If the first claim of the original patent had really been anticipated by anything described and shown in Galloway's prior English patent referred to, it would have been easy to distinguish the subject matter of Nash's invention from that of Galloway's patent, by simply insisting upon the compound movement of the piston in Nash's structure constituted by its side-rocking and rotation, as essential characteristics; and indeed, this was explicitly done by the second claim of the original patent, so that if the first claim had really been as bad as the reissue now pretends, the defect could have been readily cured by disclaimer merely.

The new claims in the reissue. Furthermore, the third, fourth, fifth and sixth claims of the reissue upon which the appellees are here charged with infringing, are manifest enlargements of claims in the original patent which embraced corresponding combinations of definite and specific elements.

This will at once be manifest upon comparison of the third claim of the reissue with the sixth claim of the original patent; the fourth and fifth claims of the reissue with the third claim of the original; and the sixth claim of the reissue with the fourth claim of the original.

The third claim of the reissue and the sixth claim of the original patent are as follow: —

Reissue.	Original.
3. A piston for water meters, pumps and motors provided with internal water passages, and having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projec-	6. A rotary valve piston having opposite end ports *d d'*, communicating with the piston sides by diagonal passages *e e'*, in combination with a cylinder having receiving and discharging ports, communicating with said opposite valve

tions and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet.

end ports and with the receiving and discharging spaces of said cylinder, whereby said valve opens some and closes others of its ports in succession, and to effect the equalization of the pressure of the water at right angles to the direction of the side-rocking and rotary movements of the said valve piston, as stated.

Each of these claims embraces, as elements of the combination specified, a side-rocking piston provided with internal water passages and a cylinder having receiving and discharging spaces; but the appellant seeks to put such an interpretation upon the third claim of the reissue that the side-rocking movement of the piston is ignored, and the internal water passages are any holes whatsoever in a piston through which the water flows; while on the other hand the sixth claim of the original patent mentions the fact that the piston is not only side-rocking, but rotary, and that the internal water passages in it are the diagonal passages *e e'*, leading from the opposite end ports *d d'*.

Nevertheless, the specification of each patent is explicit, not only that the piston has a compound side-rocking and rotary motion, but that when the piston has internal water passages they are such as the sixth claim of the original patent indicates.

The language of the specification on this latter point is as follows: —

"When the valve is arranged within the piston, it is formed by inlet and outlet openings or ports in the ends of the piston communicating by means of passages in or through the piston, with the spaces of the cylinder."

And, again: —

"When the valve is formed within the piston, as shown in Figs. 1, 2, 3, 4 and 5, the heads of the cylinder have inlet and outlet ports J and K, which must have such form as to act in connection with ports in the piston to form a valve. As shown in these figures the valve is formed within, or is a part of the piston, and it consists of ports *d d'*, in the ends of the piston communicating with lateral passages *e e'*, which communicate with the spaces *c* of the cylinder, which form the receiving and discharging divisions."

Evidently, then, the only internal water passages which either of these patents describes the piston as having are those which lead from ports in the ends of the piston laterally through it to its periphery.

The fourth claim of the reissue and the third claim of the original patent are as follows: —

Reissue	Original.
4. A piston for water meters, pumps and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber, to effect its division at two or more points on its sides into receiving and discharging spaces *c c*, which communicate with the inlet and outlet, said piston having a free movement within said cylinder, controlled only by the shape of the cylinder, the shape of the piston, and the flow of water through the meter.	3. The piston of a water meter adapted to have an eccentric or side-rocking movement across the centre of the cylinder chamber and a revolving motion, combined with a registering mechanism by means of a free or shifting connection, acting with the continually changing side-rocking movements of the piston, while maintaining a driving relation with the dial mechanism.

In each of these claims the combination specified embraces a piston which has an eccentric or side-rocking movement across the centre of the cylinder-chamber; although the claim of the original patent mentions the inherently necessary revolving motion of the piston, which the claim of the reissue, interpreted in the light of the disclaimer, strives to ignore.

Each of these claims also makes reference to a certain freedom of movement which the piston has; but the fourth claim of the reissue is broadly for "a free movement" of the piston within the cylinder; while the third claim of the original patent states more specifically that the piston is "combined with a registering mechanism by means of a free or shifting connection."

There is nothing in the specification of either patent to justify this difference in the language of the two claims. The only references

to the feature here under consideration, which are contained in the body of the specification, are as follows: —

"To accommodate this eccentric or side-rocking motion of the piston it must have a free or shifting connection with the crank or mover of the registering mechanism."

. . . . . .

"The piston is connected to the dial mechanism by a pin *o*, engaging by a free action with or operating an arm *p* of the train of the interior gear," etc.

. . . . . .

"It will be seen that the connection of the piston with the registering mechanism is such as to allow of a free or shifting action to accommodate the side-rocking movements of the piston across the centre of the cylinder-chamber and maintain a driving relation with the dial mechanism."

That is to say: the mode of connection between the piston and the registering mechanism must be free enough to accommodate the side-rocking movements of the piston during its rotation, nothing more nor less.

This is all the specification of either patent has to say on the subject of free movement of the piston; and the language of the fourth claim of the reissue shows a manifest attempt to expand the subject matter of the third claim of the original patent.

The same may be said of the fifth claim of the reissue, which differs from the fourth claim of the reissue only in specifying that the piston is "formed of hard rubber."

No claim of the original patent made this feature an element in any of the combinations claimed; and its interpolation here as part of the subject matter of invention is wholly new matter.

The only reference to it in the body of the specification is as follows: —

"I prefer to make the piston of hard rubber; but it may be made of any suitable material."

That is far from being a statement that making the piston of hard rubber constitutes any part of the patentee's invention; and there is

certainly no warrant for including such a feature in the subject matter of any claim.

The sixth claim of the reissue and the fourth claim of the original patent are as follows: —

Reissue.	Original.
6. A piston for water meters, pumps and motors having alternate bearing points or projections and recesses adapted, by means of a cylinder-chamber having alternate bearing points or projections and recesses, to have an eccentric or side-rocking movement within and upon continually changing lines across the centre of said chamber, to effect its division at two or more points on its sides into receiving and discharging spaces *c c* which communicate with the inlet and outlet, combined with ports controlled by said piston itself in its motion within said chamber.	4. The combination with a piston, having an eccentric or side-rocking motion across the centre of the cylinder chamber and a revolving motion around its own centre to divide the cylinder at two or more bearing-points on its sides, of a valve controlled by the movements of said piston and adapted to open and to close receiving and discharging porst in succession to effect the purpose stated.

These two claims are substantially for the same subject matter unless the attempt in the reissue to ignore the rotary movement of the piston be successful.

If the eccentric or side-rocking movement of the piston necessarily involves the rotation of the piston on its own axis, then the sixth claim of the reissue is not broader than the fourth claim of the original patent; but if it be possible, by virtue of the disclaimer in the reissue to construe the language of the first claim of the original patent as if the side-rocking movement of the piston and its resulting rotation were left out of account, then the sixth claim of the reissue is expanded beyond the scope and meaning of the fourth claim of the original patent.

But, if the claims of the reissue were, in fact, narrower in any sense, they can only be construed to be narrower by reason of the addition in them of more elements than were contained in the combination of the first claim of the original patent, or, in other words, by reason of the fact that such claims are for *sub-combinations*, con-

taining the elements of the original first claim with certain other elements added thereto.

If this construction be adopted, it equally renders the reissue void. In that event, we must take the effect of the disclaimer to be a conclusive concession that the original claim was an invalid claim, because it covered matter which had been previously patented or described by another, and it is well settled that for such an invalid claim a patentee cannot (after a lapse of years, and especially after intervening rights have accrued) substitute, by reissue, claims to *sub*-combinations which were not contained in the original patent.

If claims to sub-combinations were ever allowable, they could only be allowed in case they were originally omitted by accident and mistake, and where prompt application is made for the amendment; but they certainly are not allowable in a reissue taken eight years after the original patent, and especially when intervening rights have accrued.

In a very recent decision, *Carpenter Straw Sewing Machine Company* vs. *Searle*, 52 F. R. 809, Judge Coxe, after a very complete examination and citation of all the authorities, held a reissued patent to be void, —

First. Upon the ground that the new claim, which was limited by the addition of an element to the original claim, was not valid, as not being for the same invention as the original patent. The added element was referred to in the original specification but did not appear in the drawing. The Court held that: "The reissue is not for the same invention as the one actually described in the original" (p. 814), and that: "Adding a new element in such circumstances makes an independent invention, and thus, in legal contemplation, broadens the claim" (p. 815).

Second. Upon the ground that the original fifth claim was valueless, and that the infringing machine had been put on the market some time prior to the application for the reissue; and could admittedly be made tributary only to the reissued claim. The Court says: —

"It is thought that no one can read the argument in Miller *vs.* Brass Company, 104 U. S. 350, and the other decisions which follow it, without being impressed with the conviction that the injustice which the Court sought to correct was the attempt to levy tribute upon innocent parties who did not infringe the original patent and who had a right to feel themselves secure after long years of unmolested use. It cannot be doubted that any reissue which permits this wrong is within the mischief of these decisions. The case is in some respects *sui generis*, but there can be no doubt that, if sustained, the reissue will accomplish the very wrong which has been so sharply denounced by the Supreme Court. If an inventor, holding a patent with a void claim, has slept upon his rights for years until other rights have become fixed, what possible difference can it make, upon principle, whether he invades those rights and secures an inequitable advantage by means of a broader claim or a narrower claim? The complainant here seeks to do by a narrower claim (assuming it to be narrower) precisely what other complainants have vainly sought to do by an expanded claim. It cannot be doubted that the attempt is as inadmissible in the one case as in the other. In both cases the patents, after years of acquiescence, and in the light of subsequent events, are manipulated to grasp devices which the originals could not lay hold of. To permit this to be done in any case violates the spirit of the law."

See to the same effect

Hubel vs. *Dick*, 28 Fed. Rep. 132.

As already stated the Nash patent was reissued for the express purpose of covering the appellees' meter.

It is also true that in any event claims for sub-combinations must, to be allowable, appear by the face of the original patent, to be for inventions which the original patent *was intended to secure.*

In no event can claims be allowed in a reissue which the original patent had not, in fact, covered, and *was not intended to cover.*

Upon this latter point, the following, from an opinion of the Supreme Court in a recent case, will be found pertinent.

Mr. JUSTICE BLATCHFORD, speaking for the court, after quoting from a prior decision in the case of *Seymour* vs. *Osborne* (11 Wall. 516,544), which was relied on by the appellants, said: —

"In these extracts from the opinion it is seen that the court adheres strictly to the view, that, under the statute, the Commis-

sioner has no jurisdiction to grant a reissued patent for an invention substantially different from that embodied in the original patent, and that a reissue granted not in accordance with that rule is void. In what is there said about redescribing the invention, and about including in the new description and new claims what was suggested or indicated in the original specification, drawings or Patent Office model, it is clearly to be understood, from the entire language, that the things so to be included are only the things which properly belonged to the invention as embodied in the original patent; that what that invention was, is to be ascertained by consulting the original patent; and that, while the new description may properly contain things which are indicated in the original specification, drawings or Patent Office model (though not sufficiently described in the original specification), it does not follow that what was indicated in the original specification, drawings or Patent Office model is to be considered as a part of the invention, unless the Court can see, from a comparison of the two patents that the original patent embodied, as the invention intended to be secured by it, what the claims of the reissue are intended to cover.

In what was thus said in *Seymour* vs. *Osborne* there is no warrant for the view, that *ex vi termini*, what was suggested or indicated in the original specification, drawing or Patent Office model is to be considered as a part of the invention intended to have been covered by the original patent, unless the Court can see, from a comparison of the two patents, that the invention which the original patent was intended to cover fairly embraced the things thus suggested or indicated in the original specification, drawings or Patent Office model, and unless the original specification indicated that those things were embraced in the invention intended to have been secured by the original patent.

> *Parker & Whipple Co.* vs. *Yale Clock Co.*, 123 U. S. 87, 98, 99.

In *Freeman* vs. *Asmus*, 145 U. S. 226, the Supreme Court, speaking through Mr. Justice Blatchford, held a reissue invalid which was applied for within a year after the issue of the original patent, on the ground that the added claim of the reissue was for a broad invention to cover any kind of a blast furnace with a closed breast having a slag discharge opening, cooled in any manner by water.

"*There is nothing in the original specification which indicates that any such claim was intended to be made in the original patent.* On the contrary, the whole purport of that specification shows that it was intended to claim only a slag discharge piece or cinder-box constructed and attached in a specific manner."

The Court cites with approval many previous cases, and among others the above case of *Parker & Hooper Co.* vs. *Yale Lock Co.*

In *Electric Gas Lighting Co.* vs. *Boston Electric Co.*, 139 U. S. 481, 501, the Supreme Court, in an opinion by Mr. Justice Blatchford, held the reissue of the patent of Tirrell for an Electric Gas-Lighting Apparatus invalid, because the only change was the insertion of different claims, and "the new claims of the reissue are not for the same invention set forth in the claims of the original"; and further, that "the unexplained delay in applying for the reissue must be regarded as fatal to its claims."

See also

Hoskin vs. *Fisher*, 125 U. S. 217, 222, 223.
Flower vs. *Detroit*, 127 U. S. 563, 571, 572.

In order, therefore, to justify the reissue in suit, the appellant must show that the subject matter of each of the new claims, and particularly of the third, fourth, fifth and sixth claims, which are alleged to be infringed, constitute an invention *which the original patent was intended to cover;* or in other words, that the several combinations recited in these new claims were in the specification of the original patent indicated as *those things which were embraced in the invention intended to have been secured by that original patent.*

Manifestly, this cannot be shown; for not only is the language of the first claim of the original patent which has been incorporated into the new claims of the reissue incapable of being so construed as to embrace anything described in Galloway's English patent of 1846, but with or without such an interpretation of that language, neither of the combinations specified in the new claims of the reissue were described, suggested or indicated in the original patent as subject matter of invention therein intended to be covered or secured.

Furthermore, as has already been shown, the third, fourth, fifth and sixth claims of the reissue are enlargements of claims in the original patent for corresponding combinations of definite and specific elements; and the rule forbidding such a reissue to be taken has been enunciated and enforced in so many cases, beginning with *Miller* vs. *Brass Company* (104 U. S. 350), that it would be superfluous to enumerate them.

So Mr. Justice Gray, delivering the opinion of the Supreme Court said in respect to the decisions upon this point, they are "too numerous and familiar to require citation."

Farmer's Friend Co. vs. *Challenge Co.*, 128 U. S. 506, 510.

One more point calls for notice in this connection, and that is that the appellant is chargeable with fatal laches in procuring the reissue in suit, even if such a reissue seasonably obtained might have been unobjectionable.

The patentee, Lewis H. Nash, in the oath which he took Dec. 14, 1886, to support his application for this reissue, swore that Galloway's English patent of 1846 was unknown to him, and as he believed, to his attorneys, "until within the last month," that is to say, not known to him before about the middle of November, 1886.

Defendants' Exhibit File Wrapper and Contents, Nash Patent (defts.' Rec.), pp. 330, 331.

But in his deposition taken in this case he explicitly admitted that he first knew of Galloway's same English patent of 1846 about the date of the application for a patent which was granted to him Feb. 16, 1886, and was applied for Oct. 19, 1885.

Nash, Ints. 3–5, pp. 210, 211, Rec.
Patent No. 336,143, pp. 124–128 Rec.

In other words, he admits that he knew of Galloway's English patent of 1846 thirteen months before he made application for the reissue in suit; and what is more, he made a false oath in respect to such knowledge when he applied for this reissue.

Mean time, it was during just this period that the manufacture by the Hersey Meter Company of water meters, such as are complained

of as infringements in this suit, was begun and became established. Mr. James A. Tilden, the superintendent of the Hersey Meter Company testifies in relation to this manufacture as follows: —

"A few meters were sent out in the fall of 1885. Altogether about three hundred and eighty were sent out up to December, 1886."

Tilden, Int. 7, p. 214, record.

These meters were advertised extensively prior to Dec. 18, 1886, the date of application for the reissue in suit, and had been seen by John C. Kelley, the president of the appellant corporation, as he admits, prior to September, 1886, when he says the Galloway patent was first brought to his notice.

Tilden, Int. 12, p. 215, record.
Kelley, Int. 19, p. 31, Cross-Int. 26, p. 32., complts'. record.

It cannot be doubted, therefore, that the reissue in suit was procured for the very purpose of suppressing the manufacture by the Hersey Meter Company of the water meters complained of in this suit, and that the theory of anticipation of the first claim of Nash's original patent by Galloway's English patent of 1846 was concocted by the managers of the appellant corporation for the sole purpose of attempting to reach the Hersey Meter Company's manufacture.

No one, however closely he may scrutinize Nash's original patent, can for a moment suppose that before the Hersey Meter Company began to manufacture the Tilden meter the business managers or the legal advisers of the appellant corporation would have had the slightest suspicion or apprehension that the first claim of Nash's original patent was anticipated by Galloway's English patent, however long they may have known of it. The scheme of procuring the reissue here in suit is plain upon its face. It is an illegal attempt to ascribe to Nash's original patent a claim to an invention never indicated or suggested therein, and by a cunningly devised disclaimer to inject into new claims a meaning based upon the false interpretation of the original claim.

It is also an inequitable attempt to suppress a manufacture founded upon a wholly different and independent invention, by a reissue procured more than eight years after the date of the original patent, and applied for more than a year after the inventor knew of the prior patent, by reason of which it is pretended that such reissue became necessary.

Such a state of facts surely does not commend the appellant to the conscience of a court of equity.

Mahn vs. *Harwood*, 112 U. S. 354, 361.
Coon vs. *Wilson*, 113 U. S. 268, 277, 278.
Ives vs. *Sargent*, 119 U. S. 652, 662, 663.

In *Yale Lock Co.* vs. *Berkshire Bank*, 135 U. S. 342, 402, the Supreme Court, in an opinion by Mr. Justice Blatchford, held a reissue invalid where the first reissue was applied for more than two years after the grant of the original patent, and a month after the patent on defendants' devices was issued, and the second reissue was applied for four years and nine months after the grant of the original patent, and more than two years and a half after the defendants' lock had been put into use.

See to the same effect cases cited *supra:*

Electric Gas Lighting Co. vs. *Boston Electric Co.*, 139 U. S. 481, 501.
Carpenter Machine Co. vs. *Searle*, 52 F. R. 809.
Hubel vs. *Dick*, 28 F. R. 132.

The case of *Topliff* vs. *Topliff*, 145 U. S. 156, is not in conflict with these positions.

While, in some respects, a more liberal view of the power of amendment, by reissue, is indicated in that case than might have been gathered from previous decisions of the Supreme Court, yet the three qualifications of the right to reissue, expressly defined in that decision, clearly show that the present case is not one where the reissue in suit was permissible.

The Court simply held a reissue claim, applied for within five months, to be valid, because "it is *for substantially the same inven-*

tion, and, in view of the fact that the reissue was applied for as soon as the mistake was discovered and *before any rights in favor of third parties could be reasonably expected to have attached, or had in fact attached*, we think this reissue is not open to the objections which have proved fatal to so many reissues since the case of *Miller* vs. *Brass Co.* was decided."

The Court merely says in this case that a reissue with an enlarged claim may be valid if it is "for the same invention as the original patent, as such invention appears from the specification and claims of such original" (p. 170) and provided "the error has arisen from inadvertence or mistake," and that there is diligence in applying for the reissue and no intervening rights accrued.

Indeed, the second qualification excludes the present reissue, viz. :—

"that due diligence must be exercised in discovering the mistake in the original patent, and that if it be sought for the purpose of enlarging the claim, the lapse of two years will ordinarily, though not always, be treated as an abandonment of the new matter to the public, to the same effect that a failure by an inventor to apply for a patent within two years from the public use or sale of his invention, is regarded by the statute as an abandonment to the public."

Here, more than eight years elapsed between the original and the reissue, and after that lapse of time, the patentee endeavored to possess himself of new subjects of monopoly, of which there was no hint in the original patent.

Appellant's Contentions in the Court Below.

The appellant contended in the court below, that in a meter the "motion of translation" is alone essential, and that for that reason the requirement of the Nash patent and reissue that the piston must have a "rotary" and hence a "compound" motion is to be ignored, for the purpose of bringing the appellees' meter within the claims This proposition is entirely unsound.

(1) The Nash patent and reissue are specific in the requirement that his piston shall rotate as well as side rock.

(2) As a matter of fact, the side rocking of his piston necessarily involves its complete rotation, for each side rocking or eccentric

motion of his piston is a portion of its rotary motion, and the rotation of the piston is only the sum of a series of the side rockings. The two motions are inseparable in thought and in fact.

(3) Without the rotary motion of the Nash piston, no "motion of translation" that would result in measuring water would be possible. Each single side rocking is in effect a rotary movement, but if that single side rocking were not succeeded by others, making a complete rotation in the aggregate, the piston would not be a rotary meter at all. It might possibly be reorganized into a reciprocating meter, which is objectionable, as is emphatically pointed out in the Nash specification (Rec., page 94).

The appellees' meter, on the other hand, inasmuch as it does not side rock and has no eccentric motion within the meaning of the Nash patent, needs no movement of rotation.

The appellant further contended that the patentee had no *intention* to limit the first claim of his original patent or the claims of his reissue which are now relied on, to a rotating piston. This, if true, would be immaterial, for such limitation is clearly expressed and is a substantial limitation.

The arguments by which the appellant undertook to support this position are unsound. They say that this intention of the patentee to include in his claim other meters differing substantially from the several forms described by him, *all of which are identical in all material particulars and all of which have the compound movement of the patent and are mere variations on the single type for which the patent was taken out*, is shown (1) by the specification; (2) by the other claims; (3) by the history of the application; and (4) by a subsequent patent to Nash granted January 28, 1879. We contend, on the contrary, that all these considerations confirm the views for which the appellees contend.

First, In the case at bar, Nash's original patent contains no declaration, suggestion or intimation that the "eccentric or side-rocking" movement of his piston can be divorced from its rotation upon its own axis; nor that his invention embraces a structure in which the piston does not rotate upon its axis.

Nowhere within the specification of Nash's original patent is the

"eccentric" movement of the piston defined to be anything else than its "side-rocking" movement; and every form of piston described and shown in that specification is explicitly stated to have the "side-rocking" movement, which is of such character that it necessarily involves a rotary movement of the piston itself upon its own axis.

By as much as the piston side-rocks, by so much does it rotate It cannot move without side-rocking, and it cannot side-rock without rotating upon its own axis. Indeed its motion of rotation and its motion of side-rocking are one and the same. They do not occur separately or independently, but simultaneously and inseparably.

Consequently, when the first claim of Nash's original patent calls for a piston adapted "to have an eccentric or side-rocking movement," it necessarily means the only eccentric or side-rocking movement which is described in the specification, and the only eccentric or side-rocking movement of which pistons constructed as described in that specification and shown in the drawings therof are capable; namely a side-rocking movement which is also a rotary movement of the piston itself upon its own axis.

This claim cannot be construed in any other way under the rules of interpretation hitherto acted upon by the courts.

It was suggested by counsel for appellant in the court below that the general statements of the objects of the invention in the Nash patent are applicable to both complainant's and defendant's structure. We deny that proposition; but even if it were true it would be wholly irrelevant, because no such general statements in a patent can apply to a structure which is not described or even so much as hinted at in those parts of the specification where the concrete embodiment of the invention is explained and illustrated.

Every one of the statements in the Nash patent as to the functions and theory of the operation of the parts, explicitly mentions the "eccentric or side rocking" motion, action or movement of the piston, and each of the figures of the drawings in which a piston is delineated shows one which has such a side-rocking movement and which *must* rotate upon its own axis by as much as it side-rocks. Figs. 9, 10 and 11 are described in the specification as "forms of side-rocking and rotary pistons," and they do not show modifications from which

rotation of the piston upon its own axis can possibly be eliminated. None of these statements are applicable to appellees' meter.

The intention of a patentee is, of course, primarily ascertained from the language of his patent; but if resort be had to the circumstances under which Nash's original patent was obtained, it is absolutely certain that he could not, in fact, have intended to describe or claim a structure in which the piston did not rotate upon its own axis; because he did not then know of any such structure. It appears from Nash's own testimony that he had no knowledge of the Galloway engine until the fall of 1885; and of course he did not have it in contemplation as a subject to which his invention was applicable when his original patent issued January 21, 1879.

Counsel for appellant also argued that because Nash, as they said, nowhere states and nowhere suggests that the object of the combination of his original first claim was to overcome defects inherent in a non-rotating piston and because no advantage of a rotating over a non-rotating piston is pointed out or claimed to exist in the Nash patent; *therefore* the invention set forth in the first claim of Nash's original patent was intended by him to be applicable to a non-rotating as well as to a rotating piston. This is, to say the least, a very singular piece of reasoning.

Stated in another way this contention is that because the patentee did not in his patent distinguish the structure to which he applied his improvements from some other structure to which his improvements might have been applicable (although we contend not) but which was not described, referred to or hinted at in his patent, and was not even known to him when he took his patent; therefore the Court should construe his patent as though the patentee had included the ignored and unknown structure within the subject matter of his invention!

And in order to enable this thing to be done, the complainant asks the Court to disregard the meaning of "eccentric or side-rocking," as explained in the specification by reference to forms of pistons no one of which can possibly side-rock without rotating upon its axis; and to interpret the phrase as meaning neither side-rocking nor rota-

tion, but only bodily translation around the interior of the cylinder. Surely no patent was ever put to so great a strain as this.

Nor is there any force in the proposition that the doctrine of equivalency can bring the Hersey meter within the Nash patent. Nothing can be the legal equivalent of the subject matter of the first claim of Nash's original patent which does not possess substantially the features which are therein specified as characteristic of that subject matter. One of the characteristic features of the piston therein referred to is that it is adapted "to have an eccentric or side-rocking movement," which is defined with redundant explanation in the body of the specification, and which is uniformly described as a side-rocking movement which cannot take place without also involving a rotary movement of the piston on its axis.

Throughout the entire specification of Nash's original patent there is not the slightest hint or suggestion of any piston other than one which *must* rotate in order that it may side-rock; and hence it follows that under the law there can be no equivalent of the subject matter of the first claim of this patent which does not have a side-rocking, and by consequence a rotating piston.

See especially

Yale Lock Co. vs. *Sargent*, 117 U. S. 373, 377, 378;
Dryfoos vs. *Wiese*, 124 U. S. 32, 37, 38;

and comments thereon, together with other kindred cases above cited.

Second. The fact that the second claim of his original patent specifically states that the construction is such as "to allow the piston to revolve while it also side-rocks," does not tend to indicate that the side-rocking piston of the first claim is not also a rotating piston, because it could not side-rock without rotating.

In Clements vs. *Odorless Apparatus Company*, (109 U.S. 641, 647) the Supreme Court, speaking by Mr. JUSTICE BLATCHFORD, construed

the two claims of a patent in one of which an element specified in the other was omitted, as follows: —

"Claim 1 made the valve *d* in the bottom of the cask, opening to admit the entrance of material, and shutting when the orifice to the pump was closed by the float valve, a necessary element in the combination covered by that claim. Without the valve *d* the peculiarly constructed cask of the patent could not be operated. So, as to claim 2, there could be no operative combination of vault, cask and pump, unless the cask should have the valve *d*, and that valve was a part of the combination covered by Claim 2" [although not specified therein].

In like manner no piston described or shown or indicated or suggested in Nash's original patent can possibly have the side-rocking movement therein specified without necessarily having a rotary movement upon its own axis, and therefore the two movements are inseparable and cannot be divorced in any claim which involves the piston itself.

See also

Fay vs. *Cordesman*, 109 U. S. 408, 420, 421.
Crawford vs. *Heysinger*, 123 U. S. 589, 606, 607.
Wier vs. *Morden*, 125 U. S. 98, 106, 107.
Pattee Plow Co. vs. *Kingman*, 129 U. S. 294, 298.

Third. The same considerations are applicable to any intent shown by proceedings in the Patent Office while Nash's application for this patent was pending.

He described in that application only such forms of pistons as operated by side-rocking and as could not accomplish their side-rocking movement without rotating upon their axes.

Any change of claims, therefore, in which the term rotary was at first specified and then omitted as descriptive of the movement of the piston, could not alter the fact that no one of the pistons described, shown or referred to in his application and in the patent which issued thereon, could be operative without rotating upon its axis in order to perform the movement of side-rocking. Consequently, with the specification as it stood in his application or in his original patent the employment only of the term "eccentric or side-

rocking" in a claim to designate the movement of the piston, could not possibly warrant such an interpretation of the claim as to eliminate from its meaning a piston which rotated upon its axis in order to accomplish the eccentric or side-rocking movement so designated, nor indicate any intention of the patentee to eliminate such meaning from the claim.

Moreover, from the proceedings in the Patent Office (Rec., pages 231–246), it appears that, by Nash's original specification, he expressly spoke of his piston as being "a rotary piston having two motions — one of rotation around its own centre, and the other a rotation around the centre of the cylinder — by which to affect the changes in volume of the divided spaces in the cylinder by the continually changing bearing points or lines of the two parts, giving an approximately rolling motion to the piston."

Throughout the specification, he speaks continually of his piston being a rotary piston, or "a piston having a compound rotation."

The original claims, except the third, all refer to a "rotary piston" in terms, and the third, in express terms, mentions the fact that the movement of the piston is "compound," that is, rotary as well as side rocking or eccentric.

The second and third claims were rejected on a patent to Clapp for Rotary Pumps.

The applicant then amended his specification, by erasing the second and third claims, and inserting a new second claim, and a new sixth claim.

He criticised the reference to the Clapp patent, not by saying that his piston was not, in its essence, a rotary piston, but that it differed from Clapp's because Clapp had a piston "revolving *concentric* with the enclosing cylinder," whereas the movement of his piston was "utterly different," as "*both* its movements within the cylinder are effected by the direct force of the water, acting to *revolve* the piston and to carry it *eccentrically*."

Now, if any inference is to be drawn from the action so far taken, it would seem to be that not that Nash claims any piston which did

not rotate, for he erased, and did not restore, the only claim which did not have the express element of a rotary piston, but he distinguished his piston from Clapp's principally by the fact that Clapp's had a *revolving concentric* motion, whereas his had a *revolving eccentric* motion.

The second claim, even as amended, was again rejected on the same reference, and the specification was then largely erased and rewritten, and the present specification and claims substituted.

After another rejection, not of the third, but of the fifth and seventh claims, and an amendment of no special importance in this case, the patent was allowed.

It is clear, therefore, that this history in the Patent Office emphasizes our contention that the patent is limited to a piston having a *compound* motion, viz., rotary *and* side-rocking or eccentric, or a side-rocking and eccentric motion which *is rotary* in its character.

The effect of the amendment was not to show that the applicant did not consider a rotary movement essential, but that his piston had *not only* a *rotary* movement but *also* a peculiar movement which he characterized as side-rocking or eccentric.

Fourth. The opening paragraph of Nash's subsequent patent of January 18, 1879, does not tend to show that Nash had conceived of a piston which could side-rock without rotating; much less that he had intended to describe and claim a non-rotating piston in his original patent of January 21, 1879, here in controversy; but if the contrary were true, this subsequent patent would be wholly inadmissible and incompetent as evidence to control the interpretation of the prior patent.

It may be remarked that the principal contention of counsel for complainant seems to be based upon the fact that in analyzing the compound movement of the piston belonging to each of the various forms which are described and shows in Nash's original patent here under consideration, its side-rocking and its rotation are mentioned in such manner as to separate them in thought.

In the same way, the vibrations of a telephonic diaphragm when transmitting articulate speech may be so analyzed as to separate in thought the movements which impart the characteristics of pitch, intensity and quality, respectively; and yet these movements are in reality all consolidated into one movement which is called compound, because it can be conceived as the resultant of several simple movements, but which is nevertheless incapable of actual division in the speech-transmitting diaphragm.

"Eccentric Motion."

The "eccentric motion" of the Nash patent is the same as the "side rocking" motion of that patent. The appellant, in the early stages of the case, tried to base some argument upon the fact that the word "eccentric" is ambiguous except when interpreted in the light of the context and of the structure described. The fact is that the Nash piston has an "eccentric" motion, for it swings or side-rocks across the centre of the case, every individual motion being on a new centre at one side of the piston which is eccentric to the piston and its centre.

The Hersey meter on the other hand, while always "eccentric" to its case or away from the centre of the case, has a simple sliding motion and no *motion* which can be in any sense called eccentric. It may be said te *be* eccentric but cannot be said to *have an eccentric motion*. In fact its motion is *concentric* to the center of the case. This, however, is a matter of words. The substantial differences between the two structures are absolutely clear.

The appellant, however, finally concedes, in substance, that "side-rocking" and "eccentric" in the Nash patent are one and the same thing.

Brevoort, page 57, Cross-Int. 101, 102.

The Advantages of the Special Construction and Mode of Operation of the Nash Meter.

It is obvious that the peculiar side-rocking motion of the Nash meter is not only essential to its operation but is attended with decided advantages not present in the Hersey meter. In the latter the entire body of the piston has to be moved under all conditions

of use and moved by the application of the propelling power of the incoming water merely at the points of the piston, where the power is applied at a very great disadvantage. For this reason it does not and cannot be expected to operate with great delicacy. Where there is a small flow of water or but little head the friction of the piston against the sides of the case, and the weight of the piston which has to be moved as a whole by a small force disadvantageously applied, will interfere with the ease and certainty of action that is required.

In the Nash meter, on the other hand, the propelling power of the in-flowing water is applied upon the whole of one side of the piston, and instead of being obliged to move the entire piston bodily in the case, it has only to swing or "side rock" one end of it on a pivot which is diametrically across the case from the swinging point or "side rocking" end.

It is obvious that the power of the in-flowing water is much more advantageously applied where it is acting upon the whole side of the piston than where it is acting merely upon the two or three of its projections all on one side; and it is equally obvious that a small force applied to the Nash piston, which has only to side-rock the piston or swing it on a pivot, meets with far less resistance in doing its work than would be the case if it had to move the whole piston bodily, as in the Hersey structure. The side-rocking feature of the Nash piston, therefore, involves and is attended with substantial advantages which the Hersey meter does not possess. The Nash piston will undoubtedly operate satisfactorily under conditions where the Hersey structure would be practically inoperative because it has that power, due to the area acted upon and its ease of action, to overcome friction and resistance, which the Hersey piston does not have.

Moreover, the Nash piston is at all times absolutely and positively controlled in its motions. The Nash meter would operate equally well if it were arranged with its piston in a vertical position. On the other hand, the action of the Hersey piston is not positively

controlled. It is necessary that the Hersey piston should be held up to the side of its case by sufficient side pressure of the inflowing water. If that side pressure is not sufficient, the piston becomes inoperative. For instance, if the attempt were made to operate the Hersey meter with the piston arranged vertically, only failure would result. For the piston by gravity on moderate flow would overcome the side pressure and would have a spasmodic, irregular movement in the case. It would move up the side of the case to the point where gravity overcame side pressure and then fall back and start again, and would not measure water at all.

In a less degree, any disturbance from a precise horizontal position would interfere with the efficiency of the Hersey meter, but would have no effect whatever upon the action of the Nash meter.

The appellant company has a monopoly of all these advantages, because the Nash patent which it owns covers a piston which moves about in its case by a series of side-rockings from one side to another of the case, which construction and mode of operation the appellees' meter does not have.

These considerations again illustrate the substantial difference in organization and character which distinguish one of these meters from the other, and show the practical importance of those very differences.

The counterbalancing advantages of the Hersey meter, due to its peculiar structure and mode of operation, have already been pointed out.

Mr. Brevoort's Contradictions of Mr. Renwick.

Several points of Mr. Renwick's testimony are controverted by Mr. Brevoort in portions of his second deposition not already referred to. Mr. Renwick testified that he did not believe that the device shown in Fig. 10 of the patent in suit would work. Mr. Brevoort says that it will (p. 36, Int. 7), but admits in cross examination that he has only tried it to see if it will "go around," not to

see whether or not it will measure water properly (p. 72, Cross-Int. 229), and he also admits that what he calls "a servile copy" of the drawings of Figs. 10 and 11 of the Nash patent would possibly not make an operative meter. Mr. Renwick had before him only the drawings, and undoubtedly testified with reference to the structures there shown. It is another and a different question whether the general plan indicated in those drawings can be made operative by sufficient mechanical and mathematical skill on the part of a competent builder of water meters.

Mr. Brevoort also disagrees with Mr. Renwick in saying that the appellant's meter will not take up wear (p. 37, Int. 9). Mr. Renwick is unquestionably right in his statement, although it is true, as Mr. Brevoort states in the answer last referred to, that Mr. Tilden, in patent No. 385,970, has made a modification of the Nash structure which was regarded in the Patent Office as new and patentable, in which the piston will take up wear, by bringing constantly new bearing points into contact as the old ones are worn away. No one testifies that any structure shown in the Nash patent in suit would operate in this way. The fact that, years after the grant of the Nash patent, the discovery was made that, by certain modifications of the meter of that patent, it could be made to take up wear in part, does not militate against the accuracy of Mr. Renwick's testimony on this point. The principle upon which the appellees' meter is constructed enables it to wear to a fit so that it will not leak. The contrary is true of the meter shown in the Nash patent. No form of appellees' meter could be devised which would not wear to a fit, because of the inherent construction of the meter. It required a *subsequent invention*, having that special purpose in view, to give to the Nash meter this desired quality. The Crown meter, appellant's exhibit "U," produced by Mr. Brevoort as having been in use for a long time, and having worn to a fit upon the principles of Mr. Tilden's patent, No. 385,970 (which principles Mr. Brevoort seems not to understand), is unlike, in shape of piston and case, any form of meter shown in the appellant's reissue, and the porting is of an entirely different character. If it were true, that after wear it did not leak, that fact would not be material, as Mr.

Renwick's testimony was based upon the *structures of the Nash patent*, and the principles of operation characterizing those structures, not upon something new that had been subsequently devised.

But it appears from Mr. Brevoort's own testimony that Exhibit U, in its present condition, does leak to a very considerable extent (p. 69, Cross-Int. 206).

Mr. Brevoort there admits that during one revolution of the dial, when on a full stream, sixty-six pounds of water were passed, and that with an eighth stream, it passed sixty-four pounds, and testifies that if the meter had run accurately there should have passed in each case only sixty-two and one thirty-seventh of a hundred pounds.

The question of whether or not wearing to a fit is a distinguishing characteristic of the appellees' meter, is comparatively immaterial in this case. "Wearing to a fit," in its own way, does certainly characterize it and distinguish it from any modification of Nash that can be conceived of.

No reason can be suggested for the introduction into the record of this case, of the Crown or commercial meter manufactured by the appellant (Brevoort, p. 47, Ints. 34 and 35), inasmuch as while that form of meter embraces many of the inventions of the Nash patent here in suit, its piston and case are differently shaped, and it is ported on an utterly different system. The attempt of Mr. Brevoort (p. 47, Int. 36) to show resemblances between the porting of the appellees' meter and that of the Crown meter is futile. The porting of the Crown meter, as he describes it, and as it is described in the patent to Nash, No. 211,769, is entirely different from that of the appellees' meter as well as from that of the meters of the Nash patent in suit.

The sketch Exhibit B C is misleading, as it does not show enough of either meter to give any idea whatever of its porting or mode of operation.

In his third deposition Mr. Brevoort, recognizing the entire inadequacy of Exhibit B C, produced Exhibits L M and N O as illustrating the exhausts of the Crown meter and the appellees' meter. He says of Exhibit L M (which is entirely inaccurate) that it is

"what might be called a development on the plane of the passage," whatever that may mean (p. 76, Int. 252). He then proceeds to point out the obvious inaccuracies of that drawing, and makes another sketch marked "R S," which is equally inaccurate and misleading. These three drawings are entirely unintelligible. They do, however, show on their face that the Crown meter and the appellees' meter are unlike in so far as the portings are concerned, the appellees' meter having no passages whatever through the piston such as characterize the Crown meter as well as that of the Nash patent in suit. This whole discussion, however, is entirely immaterial, and no further attention will be paid to it in this brief. If the court desires to investigate the porting of the Crown meter it is fully described in the Nash patent No. 211,769 above referred to.

The Crown meter exhibit C D is, however, a balanced meter (Brevoort, pp. 57, 58, Cross-Ints. 103–110). This is an advantage, as is here admitted by Mr. Brevoort. The appellees' meter is also a balanced meter (see Brevoort, p. 69, Cross-Int. 201), while the meter of the Nash reissue is entirely unbalanced, as already pointed out (*supra*, pp. 19, 29).

Tilden's Patents and Publications.

An article of Mr. Tilden's is introduced in evidence and printed on page 79 of the record, which was read by him before the Boston Society of Civil Engineers. No special statements in it were called to Mr. Tilden's attention when he was examined as a witness. He describes in this article a number of meters which are or have been in successful use, and incidentally speaks of the advantages of using a non-corrosive material and of having a piston which "may move within its case dependent upon no journals or bearings." He says "this end is accomplished in a class of meters in which the piston is perfectly free and loose in its case," thereby being enabled "to ride over substances which would lock any rotary whose piston is mechanically confined, or rut and wear out any reciprocating meter." He is here obviously speaking of his own meter, because in the appellant's meter the piston is so tight in its case that it is constantly bearing against two points on opposite walls of the case. It cannot ride over any solid substance that may

be in the meter, but would be "locked" by foreign matter. In the appellees' meter there is sufficient play to allow any solid substance not over one eighth of an inch in diameter to pass between the piston and the wall of the case.

Mr. Tilden says in this article, —

"A step of great importance has been taken in the combination of a casing and one piston in such a manner that the piston may move within its case, dependent upon no journals or bearings."

Even if this passage referred to the Crown meter (which is very different from the Nash patented meter), that fact would be immaterial. But there is no evidence that Mr. Tilden was then speaking of the Nash meter. There may have been, and, in fact, were, other meters besides the Nash and the Tilden having this feature of construction. Indeed, the Galloway 1846 patent shows it. The Crown meter is not fairly within the language above quoted, for the Crown meter is always held in bearings on the opposite sides of the case, and those bearings determine its position. The appellant might have settled this whole question by interrogating Mr. Tilden on the subject, when he was on the stand. This its counsel did not do; and no argument on its behalf can now be based upon that portion of the article.

In the patents to Mr. Tilden there seems to occur but one phrase to which the appellees are likely to call attention. In the reissue, No. 10,778, he says that the piston is "eccentric within the chamber." This, of course, is true, but this does not imply that Mr. Tilden had any idea that his piston had an eccentric motion. It has, in fact, no eccentric motion, as has already been shown.

The appellant suggested in the court below that Mr. Tilden, the appellees' inventor, was in some way open to criticism for devising his meter. It was even asserted that he had, in his meter, imitated the casing of the "Crown" meter, a fact which if true is not significant when it is considered that it would be almost impossible to design a casing of substantially different shape for such a structure as a rotary water meter. The fact would seem to be clear, that Mr. Tilden, who knew nothing of Galloway, made a brilliant invention

by adopting principles of construction and of operation radically different from those employed by Nash, and that he copied Nash in nothing. Both invented water meters, one earlier than the other; but Tilden did not trespass in Nash's territory, whether covered by his patent or not.

Conclusion.

The appellees submit that the appellant's reissue is invalid for the reasons already stated; that the appellees' meter is an entirely different structure from that shown and described in the Nash original or reissue patent; that its principle and mode of operation are substantially different from the principle and mode of operation of the meters of the Nash reissue; that it cannot be brought within the scope of the 3d, 4th, 5th or 6th claims of that reissue; and that therefore there is no infringement.

We respectfully submit that the decree of the Circuit Court, supported as it is by a careful opinion based upon a thorough and exhaustive study of the case, should be affirmed.

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